CONSOLIDATED

SAFETY ANALYSIS REPORT

FOR

NUPAC 14D-2.0 CASKS*

TO

10 CFR 71 TYPE "A" AND

LOW SPECIFIC ACTIVITY

PACKAGING REQUIREMENTS

by

Nuclear Packaging, Inc.

815 South 28th Street

Tacoma, Washington 98409

*Formerly HN-100 Series 2 Radwaste Shipping Cask

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

1.0 GENERAL INFORMATION

1.1 Introduction

The purpose of the following document is to provide the information and engineering analysis that demonstrates the performance capability and structural integrity of the NuPac 14D-2.0 Cask and its compliance with the requirements of 10 CFR 71, Section 71.21 and Appendix A.

1.2 Package Description

The NuPac 14D-2.0 Cask is a top-loading, shielded container designed specifically for the safe transport of Type "A" levels of radioactive waste materials between nuclear facilites and waste disposal sites. The radioactive materials can be packaged in a number of different type disposable containers.

The NuPac 14D-2.0 Cask is a primary containment vessel for radioactive materials. It consists of a cask body, cask lid, and a shield plug being basically a top-opening right circular cylinder which is on its vertical axis. Its principal dimensions are 81-3/4 inches o.d. by 81-1/2 inches high with internal space of 75-1/2 inches i.d.by 73-3/8 inches high.

1.2.1 Packaging

The cask body is a steel-lead-steel annulus in the form of a vertical oriented, right circular closed on the bottom end. The side walls consist of a 3/8 inch steel shell, a 1-1/4 inch thick concentric lead cylinder, and a 7/8 inch thick outer steel shell. The bottom is four inches thick (two 2 inch thick steel plates welded together) and is welded integrally to both the internal and external steel body cylinders. The steel shells are further connected by welding to a concentric top flange designed to recieve a gasket type seal. Positive cask closure is provided by the gasket seal and the required lid hold-down ratchet binders. Four lifting lugs are welded to the outer steel shell.

NuPac 14D-2.0 casks have two (2) possible drain plug configurations. Both have the drain plug entering horizontal to the cask bottom with a double plug configuration. These configurations allow the cask to be drained with minimum operational exposure.

The design of the NuPac 14D-2.0 permits optional use of a twelve gauge stainless steel, Type 304, ASTM A-240, cask

interior cavity surface liner. The liner will be permanently installed in the cavity and seal welded along all edges.

The cask lid is four inches thick (two 2 inch thick steel plates welded together) which is stepped to mate with the upper flange of the cask body and its closure seal. Three steel lug lifting devices are welded to the cask lid for handling. The cask lid also contains a "shield plug" at its center.

The shield plug is five inches thick (two 2 inch thick steel plates and one 1 inch thick steel plate welded together) fabricated in a design similar to the cask lid. It has a gasket seal but uses eight holddown bolts instead of ratchet binders to provide positive cask closure. The shield plug also has a lifting device located at its center to facilitate handling.

The shipping cask has two closure systems: (1) the cask lid is closed with eight high-strength ratchet binders and a gasket seal, (2) the shield plug is closed with eight 3/4 inch bolts and the same seal system used for the cask lid but smaller.

The shipping cask tiedown system consists of two sets of crossed tiedown cables (totally 4) and eight shear blocks (affixed to the vehicle load bed) designed to firmly position and safely

hold the cask during transport.

The respective gross weights of the cask components and its designated radwaste loads are as follows:

Cask Body	27,800 pounds
Closure Lid	5,600 pounds
Shield Plug	400 pounds
Total Cask (Unloaded)	33,800 pounds
NuPac 14D-2.0 - Large container and waste	10,500 pounds
NuPac 14D-2.0 - 55 gallon drums (14 drums of radioactive waste)	14,000 pounds
NuPac 14D-2.0 - 30 gallon drums (18 drums of radioactive waste)	8,100 pounds

1.2.2 Operational Features

Please refer to the General Arrangement Drawing in Appendix 2.10.1. There are no complex operational requirements connected with the NuPac 14D-2.0 cask and none that have any transport significance.

1.2.3 Contents of Packaging

The cask internals consist of four separate configurations based on the types of containers to be housed: (1) One

large disposable container, (2) eighteen 30 gallon drums (including two 9 drum pallets for material handling), (3) fourteen 55 gallon drums (including two 7 drum pallets), or (4) eight 55 gallon drums (including two 4 drum pallets). All internal containers have integral leak-tight seals or closures, integral lift lugs and vertical symmetrical clearances. Drums are stacked in two tiers or levels, each on removable pallets designed to minimize interaction between drums.

The contents of the various internal containers can be process solids in the form of spent ion exchange resins, filter exchange media, evaporator concentrates, and spent filter cartridges. Materials will be either dewatered, solid, or solidified.

2.0 STRUCTURAL EVALUATION

2.1 Design Criteria

Applicable criteria are presented for each load condition as they are examined in each of the following sections. All margins of safety are with respect to ASTM A36 steels unless otherwise noted. All casks built after December 18, 1980 are built of ASTM A516 Grade 70 rather than A-36, to take advantage of the increased yield and ultimate strengths of ASTM A516 grade 70, as well as its superior low temperature properties.

2.2 Weights and Centers of Gravity

Weight information is presented in Section 1.2.1. Package center of gravity is taken to be the geometric center of the package.

2.3 Mechanical Properties of Materials

Pertinent mechanical properties of materials are given as they are used in the following analyses.

2.4 General Standards for All Packages

2.4.1 Chemical and Galvanic Reactions

The shield is constructed from heavy structural steel plates. All exterior surfaces are primed and painted with high quality epoxy. There will be no galvanic, chemical or other reaction among the packaging components.

2.4.2 Positive Closure

As noted, the primary lid is secured by means of eight high strnegth ratchet binders. The secondary lid is affixed with eight 3/4 inch diameter bolts. Therefore, the package is equipped with a positive closure system that will prevent inadvertant opening.

2.4.3 Lifting Devices

2.4.3.1 Package Lifting Lugs

The package weights used for analysis are as follows:

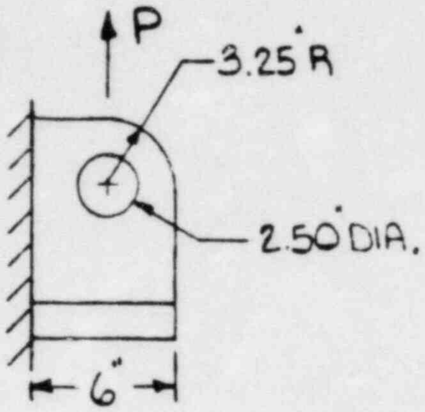
Empty Package	35,000 pounds
Payload: 14 Drums @ 1,000 pounds each	14,000 pounds
Gross Weight	49,000 pounds

Assume that only two of the four lugs are used to lift the package. Therefore, the maximum laod per lug will be:

$$P = (49,000 \text{ lbs}) \ (3 \text{ g's}) \ /2 \text{ lugs}$$

$$P = 73,500 \text{ lbs.}$$

From the drawing:



Using the Structural Methods Manual, SSD 60048R, Hughes Aircraft Co., Figure 4.4.1-1 and 4.4.1-3, given on pages 2-4 and 2-5:

$W/D = 6/2.5 = 2.4$ & $R/D = 3.25/2.5 = 1.3$

$K = 1.21$

Ultimate lug capability is given by:

$P_{ult} = K \, D \, t \, F_{Tu}$ Where: $K = 1.21$

$D = 2.5$ in.

$t = 2.0$

$F_{tu} = 58,000$ psi (A-36)

$P_{ult} = (1.21)(2.5)(2.0)(58,000)$

$= 350,900$ lbs (ultimate)

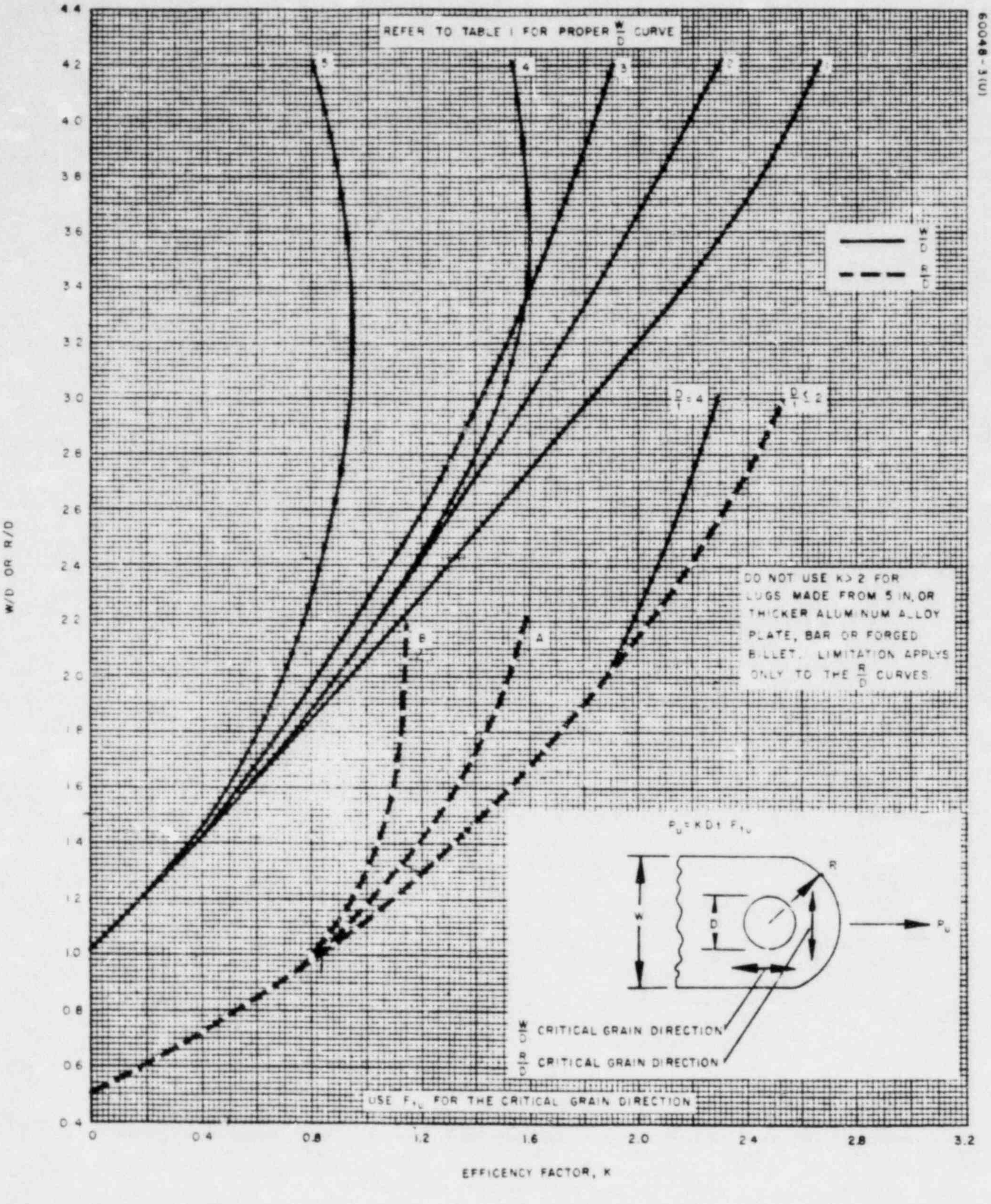


Figure 4.4.1-1. Axially Loaded Lug Design Chart

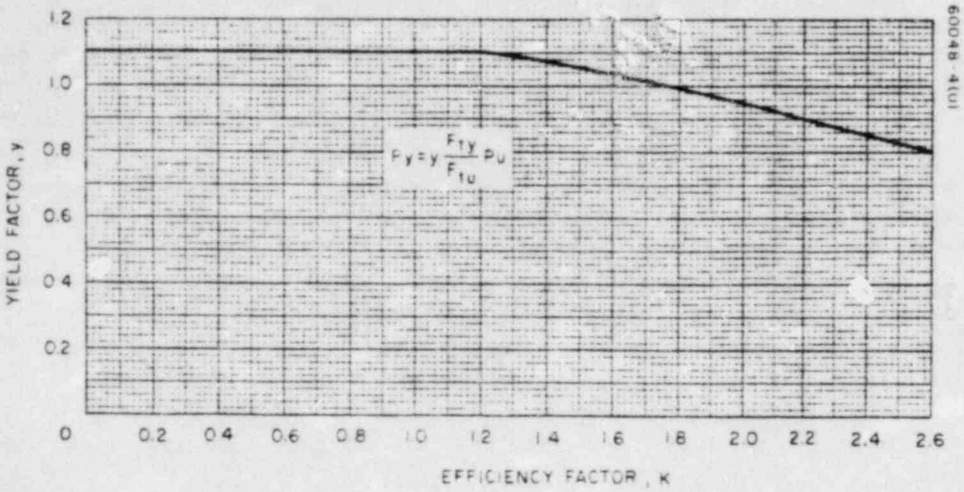


Figure 4.4.1-2. Yield Correction Factor for Axially Loaded Lugs

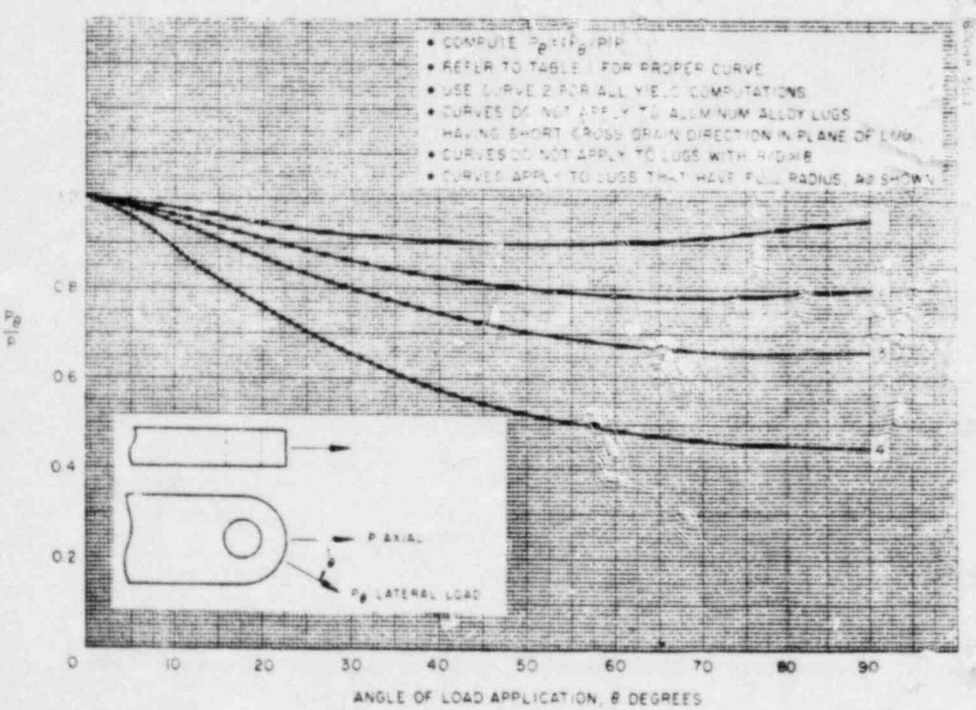


Figure 4.4.1-3. Allowable Lateral-Lug Loads

From Figure 4.4.1-2, of the above reference, the yield correction factor is given to be

$y = 1.1$ or:

$$P_{yld} = P_{ult}\ y\ F_{ty}/F_{Tu}$$

$$= (350{,}900)(1.1)(36\ 000)(58{,}000)$$

$$= 239{,}580 \text{ lbs (yield)}$$

Margin of Safety:

$$M.S. = P_{yld}/P - 1$$

$$= 239{,}580/73{,}500 - 1$$

$$= + 2.26$$

Therefore, it can be safely concluded that the lug will not yield under a load equal to three times the weight of the package.

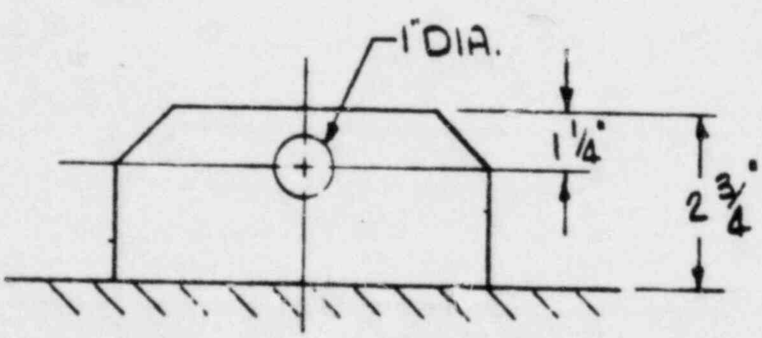
2.4.3.2 Lid Lifting Lugs (Primary and Secondary)

Lid Weight = 6,200 lbs.

Using three lugs the load per lug is:

$P = (6200 \text{ lbs})\ (3 \text{ g's})/3 \text{ lugs}$

$P = 6200 \text{ lbs/lug}$



Using the conventional 40° shear out equation,

$$P_s = F_{sy}\ 2g\ (E.M. - \frac{d}{2} \cos 40^{\circ})$$

Where: F_{sy} = 24,000 psi (yield)

t = 1 inch

d = 1 inch

EM = 1.25

$$P_s = (24{,}000)(2)(1)(1.25 - 1/2 \cos 40^{\circ})$$

$$P_s = 41{,}614 \text{ lbs.}$$

Margin of Safety:

$$M.S. = P_s / P - 1$$

$$= 41{,}614/6200 - 1$$

$$= + \text{Large}$$

Therefore, it can be concluded that the lifting lugs for the lid are more than adequate to resist a load of three times the cask weight.

The secondary lid is lifted by one lug and must carry the following load:

$$P = (400 \text{ lbs})\ (3\ g\text{'s})$$

$$= 1200 \text{ lbs.}$$

$$P_s = (24{,}000)(2)(.375)(.5625 - .4375 \cos 40^{\circ})$$

$$= 4092 \text{ lbs.}$$

Margin of Safety:

M.S. = 4092/1200-1

$= + 2.41$

Therefore, the secondary lid is also able to react three times its weight without reaching a yield stress.

2.4.3.3 Lifting Lug Covers

Since the primary and secondary lid lifting lugs are not capable of reacting the full weight of the package they will be covered during transit.

2.4.3.4 Ultimate Lug Failure

Each lug is designed to tear out at the eye prior to failure of the lug to skin interface. The most critical lug is the main package lifting lug. Each lug is secured to the skin with approximately 62 linear inches of weld. Its rated shear value would be:

$P_s = F_s A$

$= (24{,}000 \text{ psi})(62 \text{ in})(.50)/.707$

$= 1{,}052{,}333 \text{ lbs.}$

Compare this to the lug tear out capacity of 350,900 lbs, the Margin of Safety will be large:

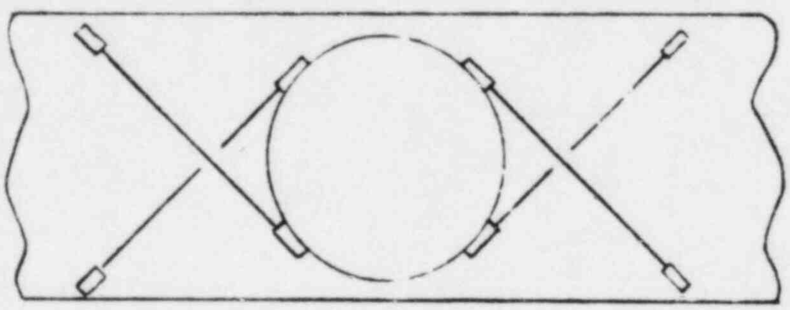
M.S. = 1,052,333/350,900-1

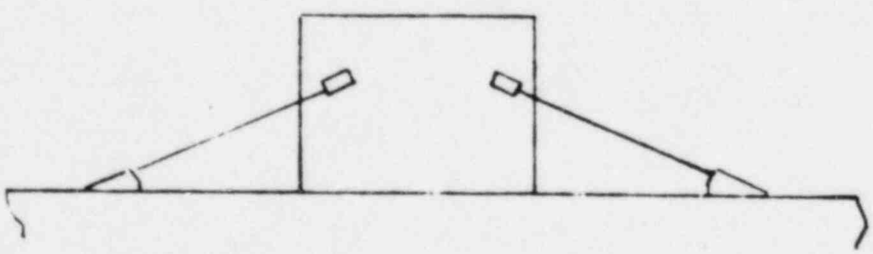
= + 1.99

Therefore, the lugs will not fail in a manner that would be harmful to the package integrity.

2.4.4 Tiedowns

A system of tie down lugs are provided as part of the package. They will be utilized as follows:



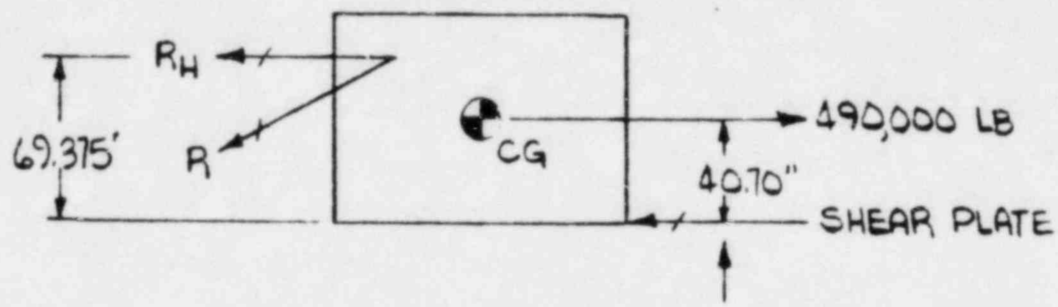


The worst condition is that of the 10 g forward load

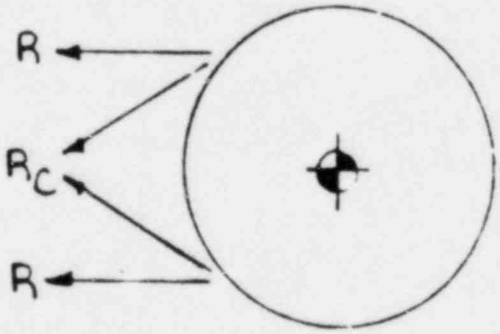
$$P_{10} = (10)(49{,}000 \text{ lbs})$$
$$= 490{,}000 \text{ lbs}$$

The horizontal component for each lug is:

$$R_H = 490{,}000\ (40.7)/(2)(69.375)$$
$$R_H = 143{,}733 \text{ lbs.}$$
$$R = R_H/\cos 30^\circ = 165{,}968 \text{ lbs.}$$



The cross tie component will give:



$$R_C = R/\cos 30^\circ - 191{,}644 \text{ lbs.}$$

Therefore, each lug will experience a load of 191,644 lbs.

From Section 3.1.3.1, the yield strength of the lug was calculated to be:

P_{yld} = 239,580 lbs

Margin of Safety:

M.S. = 239,580/19o,644 - 1

= + .25

Therefore, it can be concluded thatthe 10 g load will not produce stress in the lug greater than its allowable yield strength. If the load were increased to approximately 21 g's, thelug would fail at the hole. This would not impair the cask's ability to meet the other requirements of Section 71.31.

2.5 Standards for Type B and Large Quantity Packaging

This section is not applicable, since the NuPac 14D-2.0 Cask is not a Large Quantity or Type B Package.

2.6 Normal Conditions of Transport

2.6.1 Heat

Since the package is constructed of steel and lead, temperatures of 130°F will have no effect on the package.

2.6.2 Cold

All packages manufactured after December 18, 1980 are fabricated from ASTM A516 Grade 70 steel, which retains excellent structural properties at -40°F. Therefore, an ambient temperature of -40°F will have no effect on the package.

2.6.3 Reduced Pressure

A .5 atmosphere pressure will produce an equivalent internal pressure of 7.1 psi. This pressure acting over the lid will produce a load of:

$$F = (75.5)^2 (\pi) (7.1)/4 = 31,786 \text{ lbs.}$$

Since there are eight binders, the load per binder will be:

$$P = 31,7\ 6/8 = 3,973 \text{ lbs/binder}$$

Each binder has an ultimate strength of 85,000 lbs.

Therefore, it can be concluded that the reduced pressure will produce no detrimental effects.

2.6.4 Vibration

All components are designed for a transportation environment. No loss of integrity will be experienced.

2.6.5 Water Spray

Not applicable.

2.6.6 Free Drop

Since the package weighs in excess of 30,000 lbs., it must be able to react a one foot free drop onto any surface. For this case, the most critical component will be the lid closure.

Assuming the package to be dropped one foot onto the lid corner the impact energy will be absorbed by inelastic deformation of the steel corner.

$$K.E. = Wh$$

or:

$$K.E. = F_{cf}\text{Volume} = D^4(\sin\theta - \sin^3\theta/3 - \theta\cos\theta)/8L/F_{cr}$$

Where:
- $W = 49{,}000$ lbs
- $h = 40$ in.
- $D = 84$ in.
- θ = Contact Angle
- $F_{cf} = 36{,}000$ psi

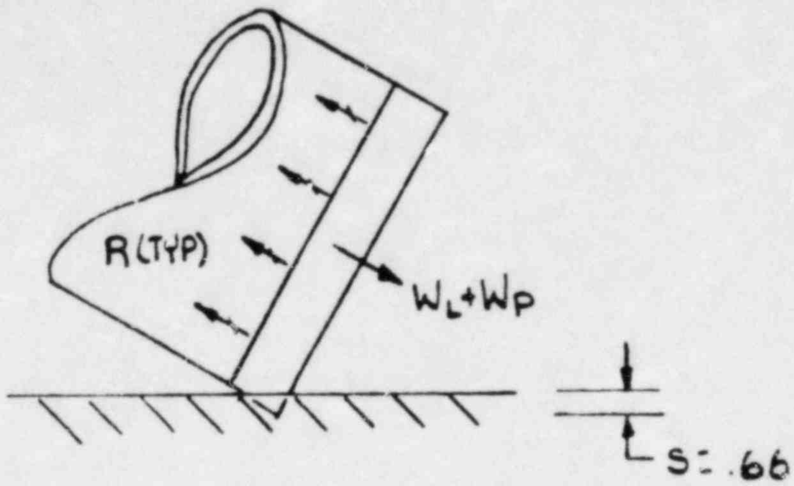
Solving the equation, the local deformation to the package will be:

$S = .66$ in.

Therefore, package acceleration can be calculated as follows:

$$a = (12 \text{ in}/.66 \text{ in}) \text{ g's}$$

$$a = 18.18 \text{ g's}$$



If we conservatively assume that the total payload and lid weight to be solely reacted by the binders then each must carry the following:

$$P = \frac{(14{,}000 \text{ lb payload} + 6{,}200 \text{ lb lid})\ 18.18 \text{ g's}}{8 \text{ binders}}$$

$$P = 45{,}904 \text{ lbs/binder}$$

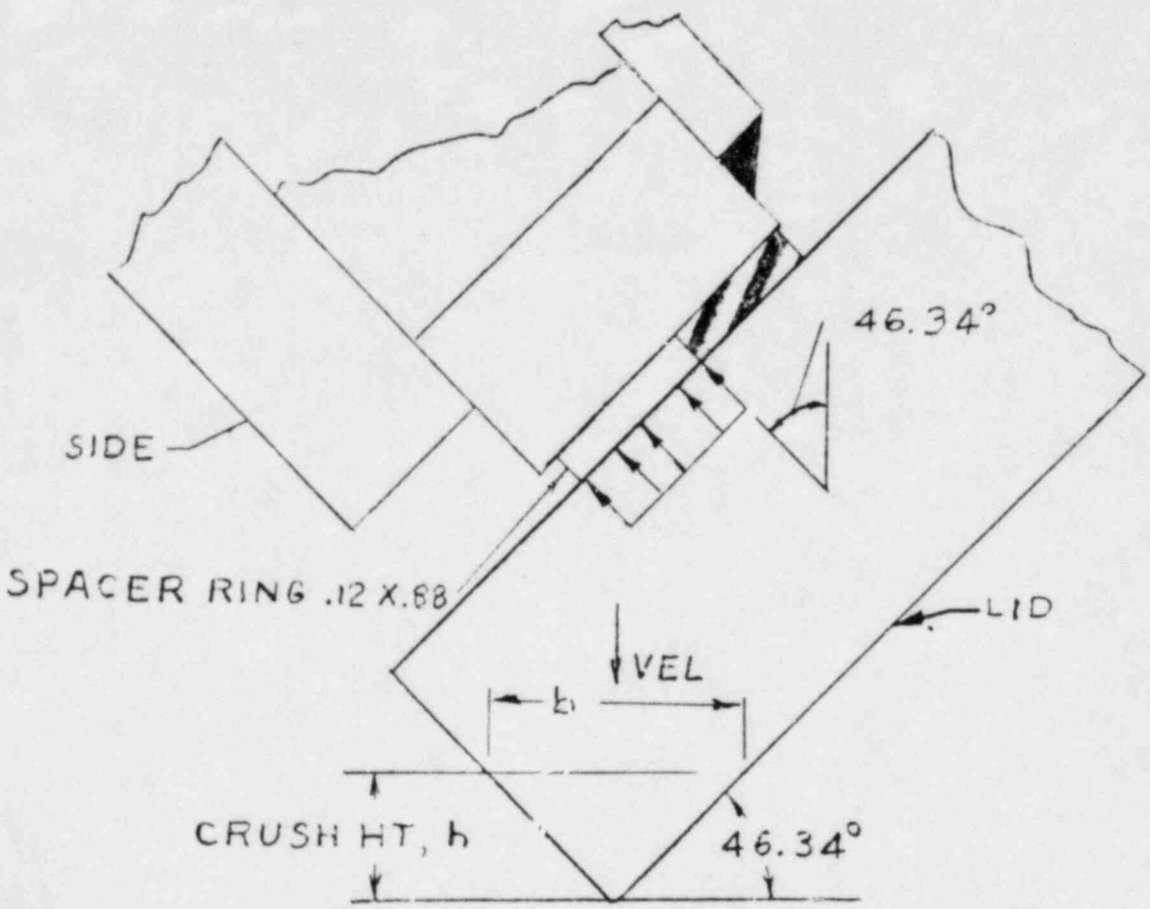
The ultimate strength of the binder is rated at 85,000 lbs.

Margin of Safety: M.S. = 85,000/4[illegible] 904 - 1

= + .85

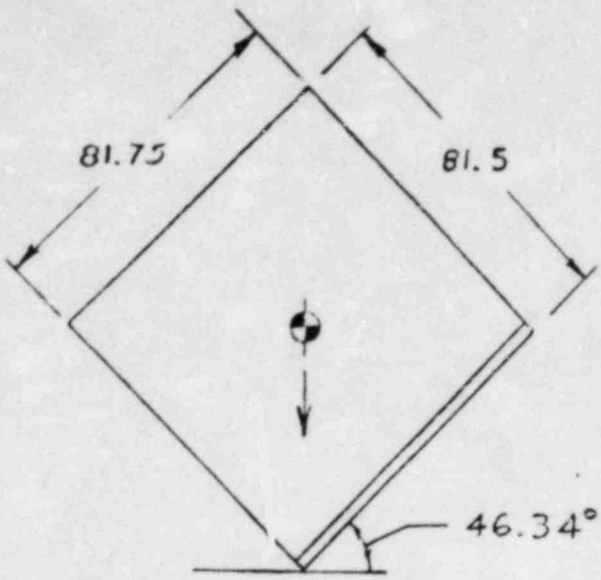
Gasket Seal Integrity

The gasket design requires a protective steel spacer. The spacer is in the form of a ring and is welded to the top of the case where the lid interfaces with the case. See figure below. The lid compresses the gasket and bottoms on the spacer.



Cross Section of Upper Case

The worst case causing stress on the spacer is the edge drop. The deceleration is greatest here and the CG is directly over the edge.



Net Wt. = 34K#

Payload = 14K#

Gross = 48K#

Position of Cask at Edge Drop

The drop height of 12" and a gross weight of 48,000 lbs. yields a kinetic energy KE = (12)(48,000) = 576,000 lbs/in.

The flow stress is 45,000 lbs, giving a displacement V of:

$$V = \frac{576,000}{45,000} = 12.8 \text{ in.}^3$$

The volume displaced is in the shape of a prism with a triangular cross section of the length L of the edge.

$$L = (85.38)(\tan 22.5^{\circ}) = 35.4 \text{ in.}$$

Therefore, the volume is bhL/2 as shown on the previous page. the base b is:

$$b = \frac{h}{0.499}$$

Therefore: $V = bhL/2$

$b = h/0.499$

$v = h^2L/(2)(0.499)$

$$h = \sqrt{\frac{(0.998)(12.8)}{35.4}}$$

$h = 0.601$ in.

The maximum deceleration Ag is twice the drop height H divided by the displacement height h.

$Ag = 2H/h = (2)(12)/0.601 = 39.9g's$

Deduct the mass of the lid and payload, since these do not contribute to loading on the spacer. Lid weight is 7,000 lbs, therefore net weight Wn is:

$Wn = 34,000 - 7,000 = 27,000$ lbs.

Stress on 35.4 in. length of spacer is:

$$S_{sp} = \frac{P}{A} = \frac{(27000)(39.9\ g's)(\cos 46.34^{\circ})}{(0.50)(35.4)}$$

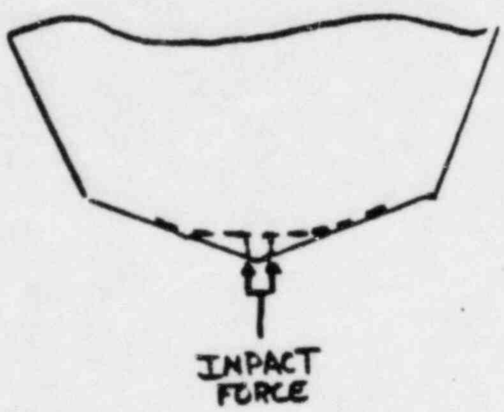
$S_{sp} = 42,020$ psi

The bearing strength of A-36 is 90,000 psi. Therefore, the M.S.:

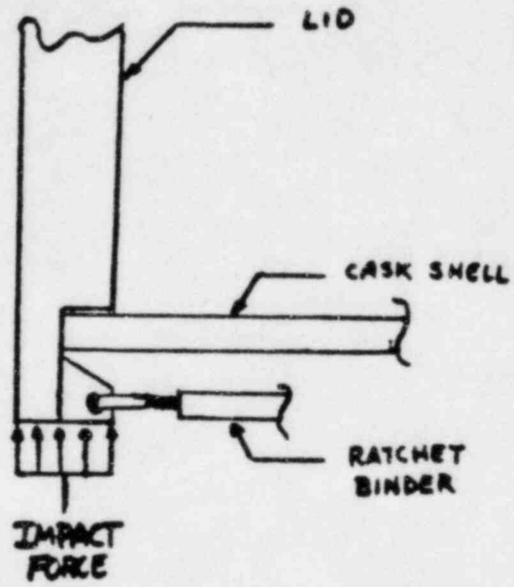
$$M.S. = \frac{90,000}{42,020} - 1 = + 1.14$$

Lid Attachment Strength

To demonstrate that the lid will remain attached to the cask during a one foot side drop, the worst case situation will be considered occurring when the impact force acts solely on the segment of the octagon shaped lids that protrude most from the edge of the cask shell and to which the ratchet binder is attached as shown below:



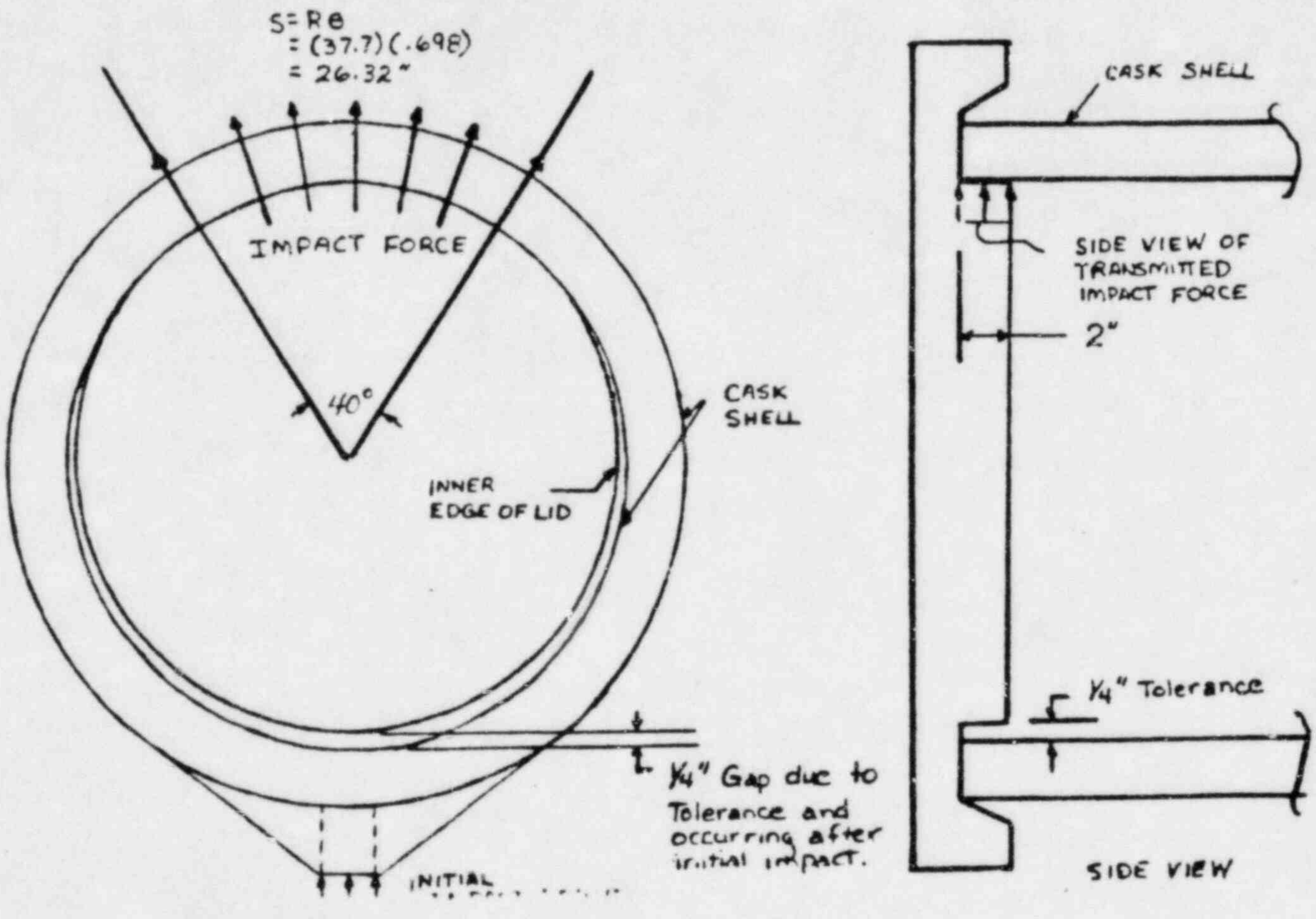
VIEW LOOKING DOWN ON TOP



SIDE VIEW

Since the inner segment of the lid acts on the cask shell in a manner similar to a bolt's shaft acting on a drilled plate, a simplified conservative approach to a complex analysis of the total internal forces caused by elastic and inelastic deformation

of steel and lead acting on the shell from the lid's transmittal of impact forces is to use the conventional 40° bolt shear-out method on the side of the cask opposite from the impact force, with the major analytical differences being that the lid does not go completely through the cask as a bolt would go through a drilled hole; so the 26.32" arc length of the 3/8" thick inner cask steel plate at the bottom of the 2" inside lid depth will also resist the impact force.



An enlarged view of the cask shell where the transmitted impact force acts from the lid shown below.

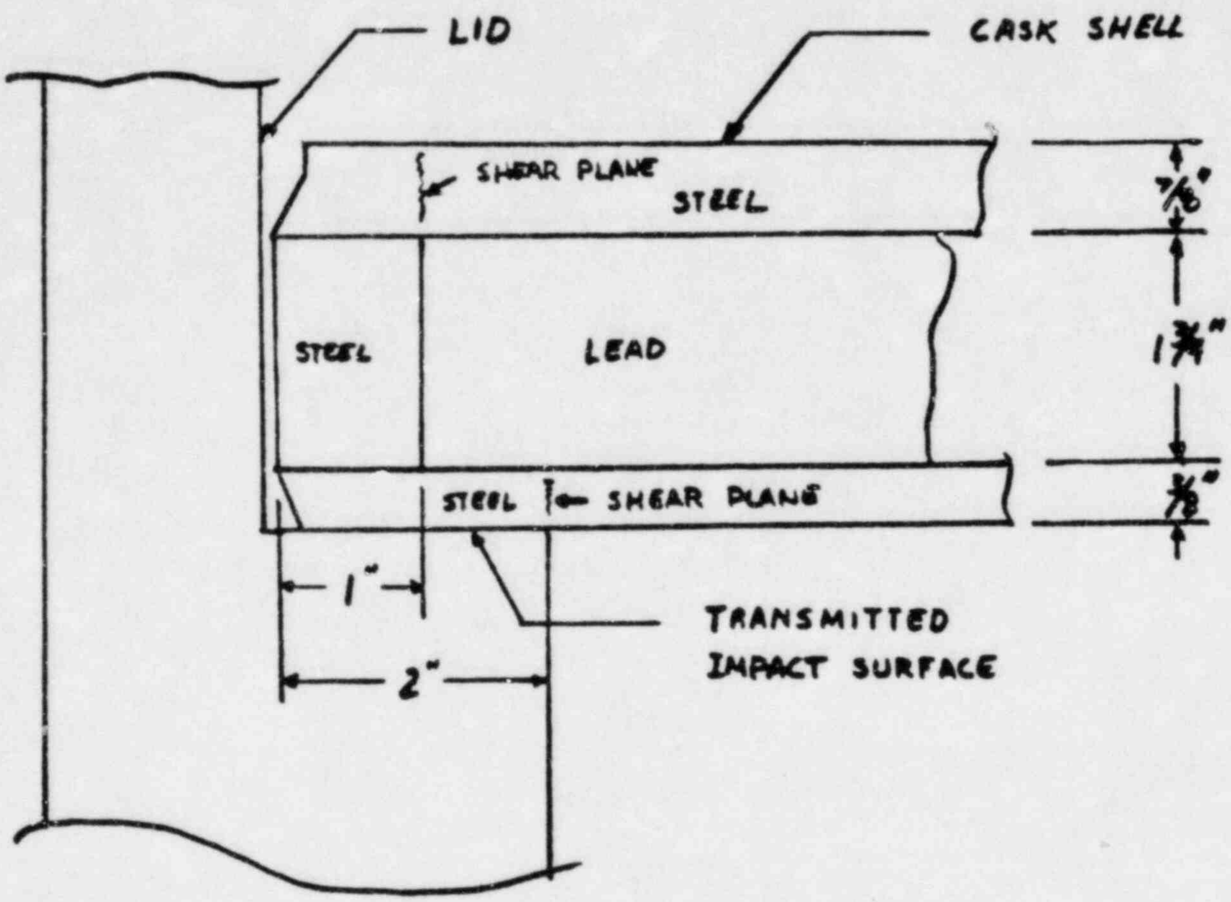


Figure 2.6.6-1

Lid Analysis

The inelastic deformation caused by the 1 foot side drop will occur at the protruding lug rather than at the lid/cask interface inside the shell on the opposite side from lug, based on the following reasoning:

From, Pressure = $\frac{\text{Force}}{\text{Area}}$, and assuming the 49,000 lb. weight at rest; the pressure at the lug is $\frac{49000 \text{ lbs.}}{5 \text{ in.}^2}$ = 9,800 psi. The pressure at the lid/cask interface is $\frac{49,000 \text{ lbs}}{26.32\text{x}2}$ = 931 psi.

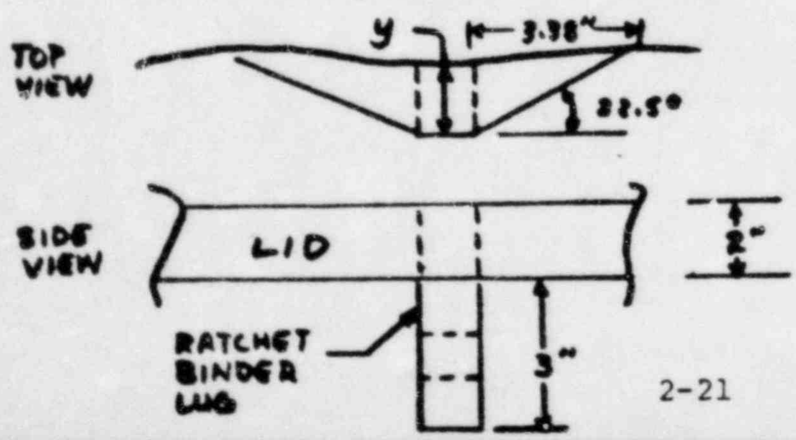
since the pressure at the lug is more than ten times that at the lid/cask interface, the lug will crush prior to shell deformation; the crush distance calculated below:

$$\text{From K.E.} = F_{CR} \text{ Vol, Where } F_{CR} = 36{,}000 \text{ psi for A36}$$

$$V_1 = \frac{\text{K.E.}}{F_{CR}} = \frac{(49{,}000 \text{ lbs})(12 \text{ in.})}{36{,}000 \text{ lb/in.}^2}$$

$$= 16.34 \text{ in}^3 \text{ needed to absorb impact}$$

From the geometry of the protruding lug, and trial and error; the sketch below shows the instance of crush necessary for the crushed volume to equal the area 16.34 in^3 "needed" volume:



$y = 1.4"$

$x = \frac{1.4}{\tan 22.50} = 3.38"$

x = 3.38", the volume of crushed metal is:

$V = (5" \times 1" \times 1.4) + 2((3.38 \times 1.4))$

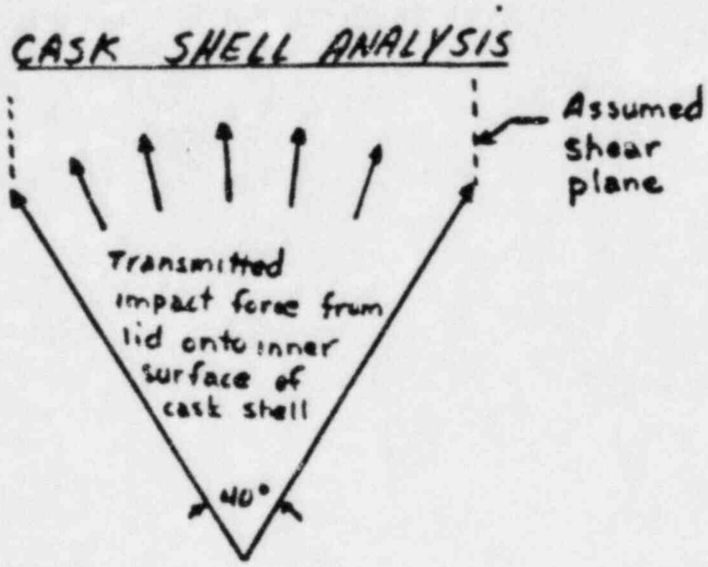
$V = 16.464$

Therefore, the "g" force can be closely approximated from:

$$a = \frac{\text{Distance Dropped}}{\text{Distance Deformed}} \text{ g's}$$ (Cask Designer's Guide)

$$a = \frac{12''}{1.4''} = 8.6 \text{ g's}$$

This is the total force acting on the opposite side of lid, or on binders if cask deforms enough to cause the vertical force on the lid to be converted into tensile force on the binders.



From Figure 2.6.6-1, the cask shell will shear across 2" x 26.32" of 3/8" thick plate and on both its ends 1" x 1-3/4" ends of steel cap, and 1" x 26.32" of 7/8" thick plate.

Arc length = $R\left(\frac{40\pi}{180}\right) = (37.7) = 26.32''$

$$\text{Shear-out} = \frac{\text{Force}}{\text{area}} = \frac{49{,}000 \text{ lbs} \times 8.6 \text{ g's}}{2(2''\text{x}.375) + (26.32 \times .375) + 2(1\text{x}1.75) + 2(1\text{x}.875) + (.875 \times 26.32)}$$

$$= \frac{421{,}400 \text{ lbs.}}{39.65 \text{ in.}^2}$$

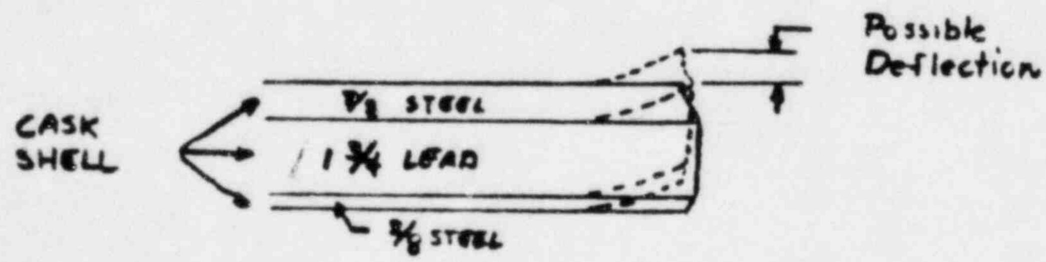
$$= 10.618 \text{ lb/in}^2$$

When compared to yield of A-36 material: $\frac{36,000}{10,618} - 1 = +2.39$
Margin of Safety

When compared to ultimate: $\frac{58,000}{10,618} - 1 = +4.46$ Margin of Safety

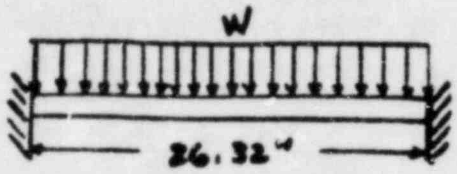
The above is conservative since it ignores the shock-absorbing contribution of lead.

The previous calculation was based on the assumption that all the impact loading was converted into shear on the cask shell. Due to the geometry of the shell components, and the fact that the 1" x 1-3/4" capping ring receives additional support from the entire periphery of the cask, it is assumed that only a small amount of "cantilever" type deflection will occur at the top of the cask's lip as shown below:



To check this possible deflection however, a conservative approximation through the simple-beam approach will be used. The circular section of the 40° shear-out area is "flattened out" with the two ends considered fixed and conservatively ignoring that the 3/8" plate is "fixed" 2" from cask up for

the full 26.32" lid/cask interface.



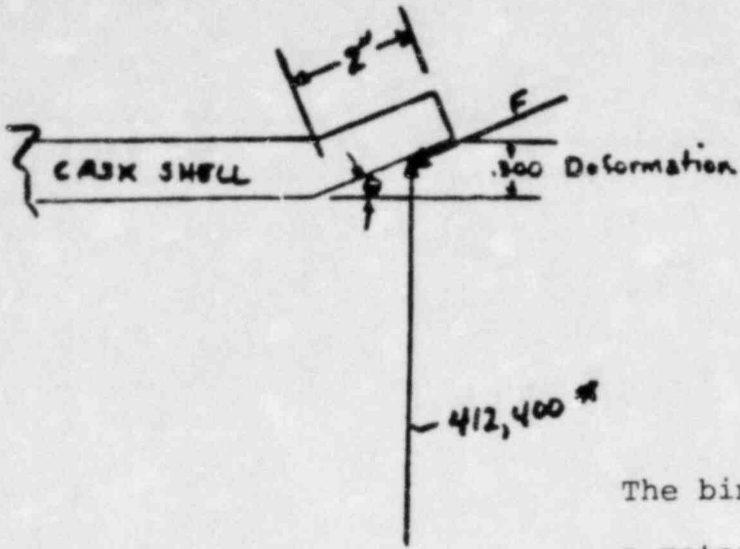
Maximum deflection: $y_{max} = \frac{1}{384} \frac{W\ell^3}{EI}$ (From Roark)

$$= \frac{1}{384} \frac{(421,400)(26.32)^3}{(30\times10^6)\left(\frac{2\times3^3}{12}\right)}$$

$$= .297" \approx .300"$$

NOTE: The above also conservatively assumes that the full "g" loading goes into deflection and not partially into inelastic deformation/shear of the inner shell.

If the upper part of the cask lip deflects .300"; and since the ratchet binders are attached to the lid and cask by pinned joints and therefore, can experience only tensile forces, the deflection will convert into the below tensile force acting on the binder opposite the deflection.



$\sin\theta = \frac{.300}{2} = .15$

$\theta = 8.6^{\circ}$

$\cos\theta 81.4^{\circ} = \frac{F}{412,400}$

$F = 412,400(.149)$

$F = 61,669$ lbs.

The binder is a 1-3/8" binder with a rated capacity of 85,000 lbs.

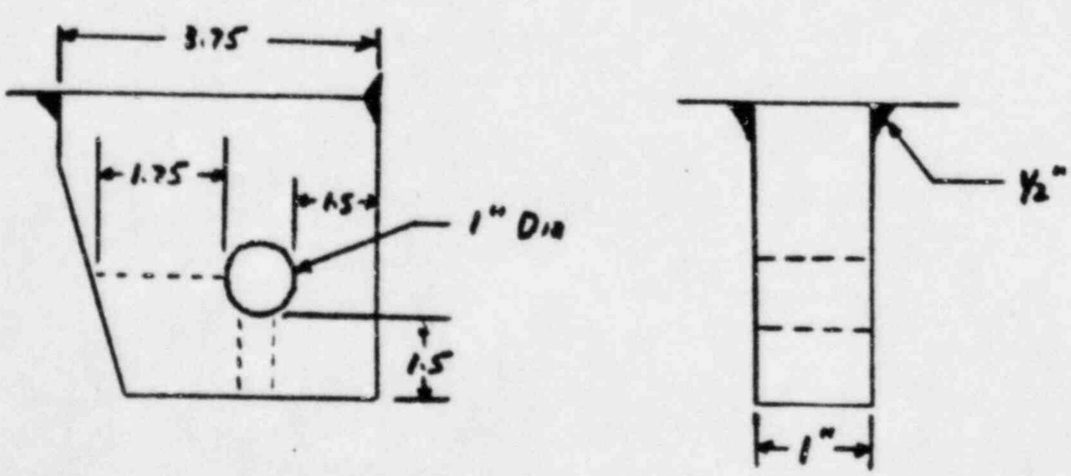
The resulting margin of safety is:

$$\text{Margin of Safety} = \frac{85,000}{61,669} - 1 = +.38$$

Also, this is conservative since more than one binder will share the load.

Lid-lug Analysis

Calculating lid lug shear out using the dimensions given in the sketch below:



© REF 3

$\sigma_s = F/A$ Shear $= .6 \times Ult_{min}$

$F = \sigma_s A$ $= .6 \times 58,000$

$F = 34,800 \text{ lb/in}^2 (2\text{x}1\text{"x}1.5)$ $= 34,800$ psi

$F = 87,000$ lbs.

Margin of Safety $= \frac{87,000}{61,669} - 1 = + .41$

Bearing failure will occur before tensile due to geometry and higher sigmas:

The lid to lug weld strength can be analyzed as follows, assuming a weld efficiency (α) of .9, A36 shear strength (S_t) of 21,000, and weld size of 1/2 inch:

$$F_t = \alpha S_t \ (.707\alpha)L$$

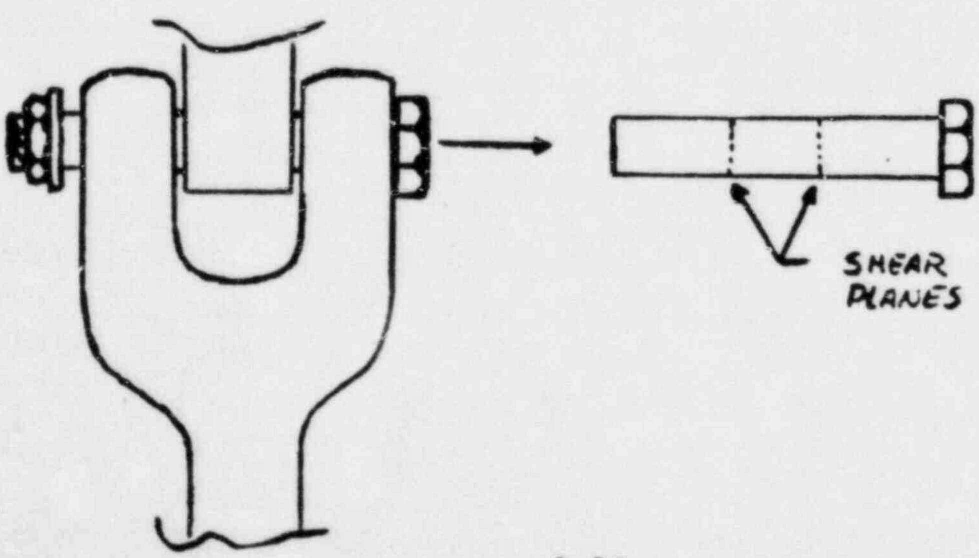
$$F_t = (.9)(21,000)(.707)(.5)(2\text{x}(3.75+1))$$

$$F_t = 63.470$$

Margin of Safety $= \frac{63,470}{61,669} - 1 = + .03$

<u>Ratchet Binder Pin Attachments</u>

The ratchet binder pin is in double-shear: (61,669 lbs load)



1" dia pin: $A = \pi r^2 = 3.14 \times (.5)^2$

$A = .79 \text{ in.}^2$

Total shear area $= 2 \times .79$

$= 1.58 \text{ in.}^2$

ASTM A-320 Ultimate Tensile Strength = 105,000 psi

Shear Strength $= \sigma = .6(105,000 \text{ psi})$

$= 63,000$ psi

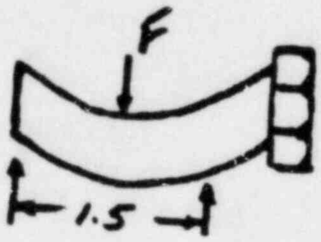
$F_{capacity} = \sigma A$

$= 63,000(1.58)$

$F_{capacity} = 99,540$ lbs.

Therefore, Margin of Safety $= \frac{99,540}{61,669} - 1 = \underline{+.61}$

Max Deflection of Pin (Bending)



$$y_{max} = \frac{F\ell^3}{3EI} \qquad I = \frac{\pi D^4}{64}$$

$$= \frac{61,669\ (1.5)^3}{3(30\times10^6)\frac{\pi(1)^4}{64}}$$

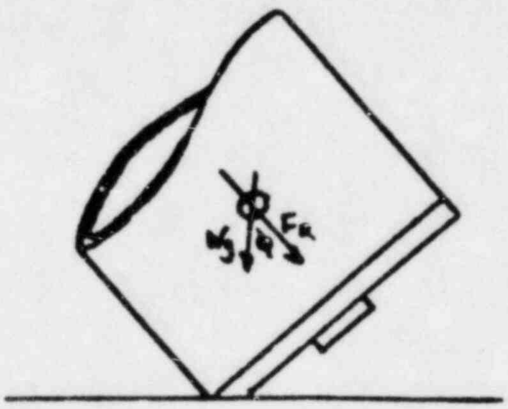
$$= \frac{61,669\ (3.37)64}{3(30\times10^6)(3.14159)}$$

$$= \frac{1.33 \times 10^7}{2.82 \times 108}$$

$$y_{max} = .047 \text{ in.}$$

Shield Plug Bolt Analysis

The stress in the shield plug bolts can be determined by the following analysis, assuming that the payload and plug weight totals 14,000 lbs; that there are eight 3/4 inch bolts restraining the plug; the plug experiences 18.18 g's; and the yield stress of the A-320 bolts is 105,000 psi:



$F_R = W \times g \times \cos\phi$

$F_R = 14{,}000 \times 18.18g \times .707$

$F_R = 186{,}373$ lb. acting on shield plug

Typical root area for 3/4" dia. bolts:

$$A = \pi r^2 = 3.14\ (.375)^2\ in^2$$

$$A = .442\ in.^2$$

Load carrying capacity of 8 (shield plug) bolts, equally sharing load:

$$F_c = \sigma_{typ}\ A \times 8$$

$$F_c = (105{,}000\ lb/in.^2)(.442\ in^2)(8)$$

$$F_c = 371{,}280\ lbs.$$

$$\text{Margin of Safety} = \frac{371{,}280}{186{,}373} - 1 = \underline{+.99}$$

Therefore, it can be safely concluded that the package can survive the one foot drop.

2.6.7 Corner Drop

This requirement is not applicable since the 14D-2.0 Cask is fabricated of steel.

2.6.8 Penetration

Impact from a 13 pound rod will have no effect on the package.

2.6.9 Compression

This requirement is not applicable since the package exceeds 10,000 pounds.

Conclusion

From the above analysis, it can be concluded that the NuPac 14D-2.0 Cask is in full compliance with the requirements set forth in 10 CFR 71 for Type "A" Packaging.

2.10.1 General Arrangement Drawing

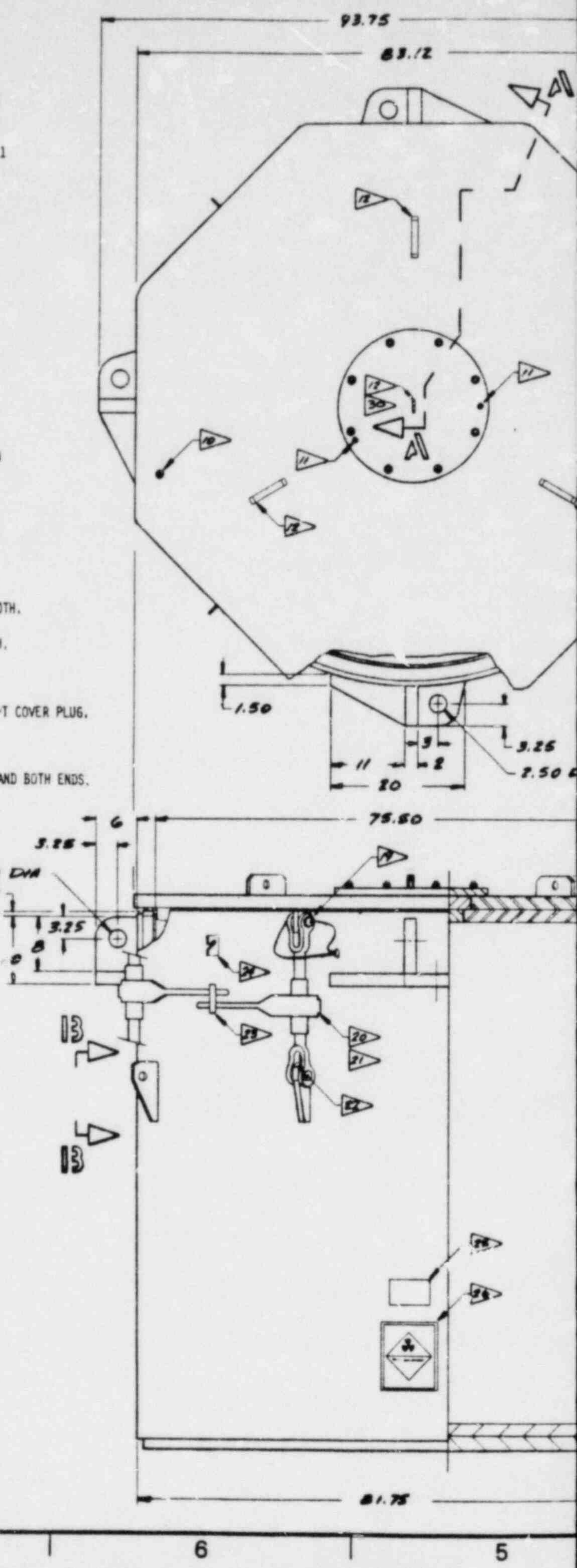
NuPac X-20-215D

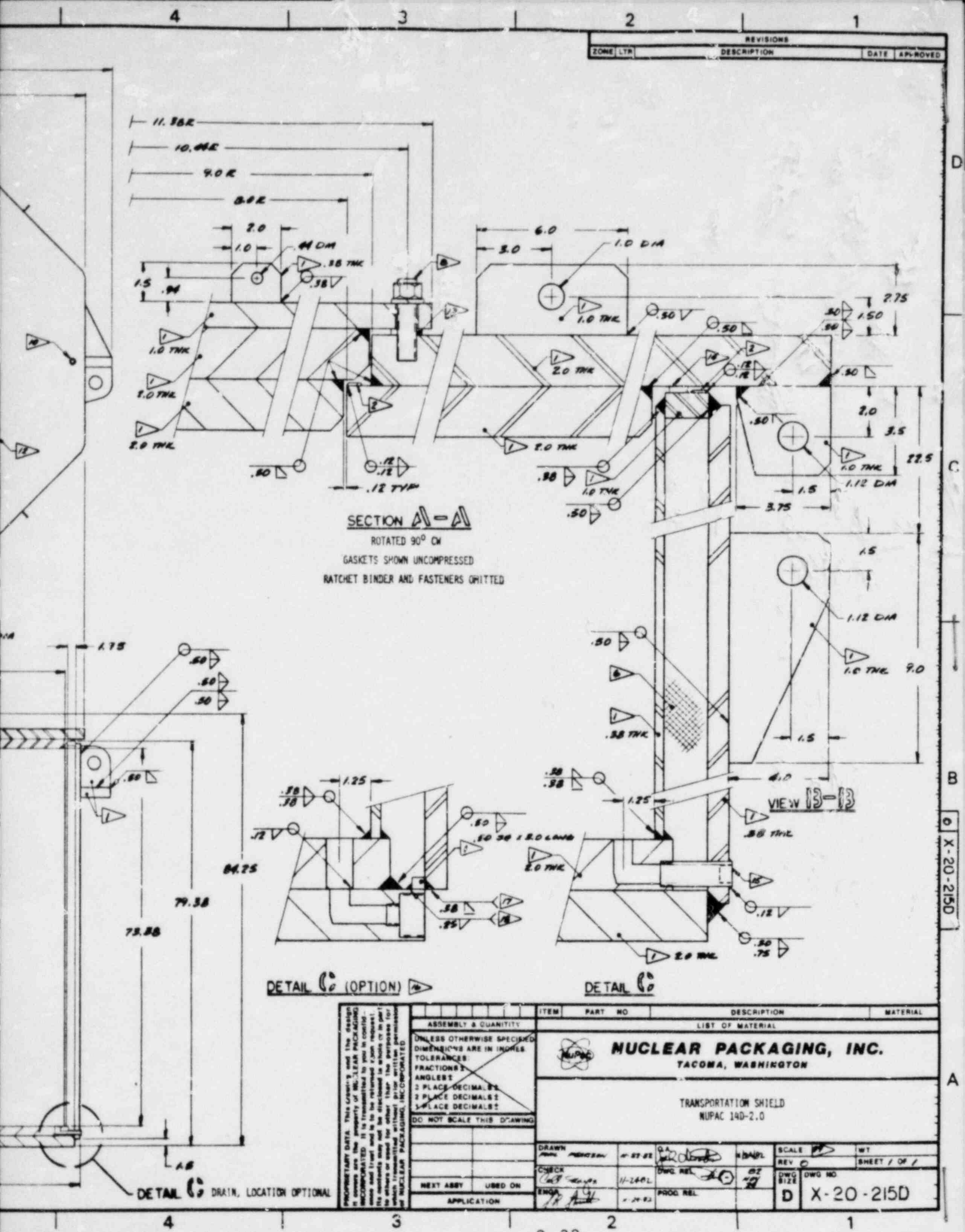
NOTES, UNLESS OTHERWISE SPECIFIED;

1. MATERIAL: ASTM A516, GRADE 70
2. MATERIAL: AISI 10C3 OR EQUIVALENT, .12 THICK, MINIMUM .50 WIDE.
3. TRANSPORTATION SHIELDS FABRICATED PRIOR TO DECEMBER 18, 1980 MAY BE CONSTRUCTED UTILIZING ASTM-A36 OR EQUIVALENT MATERIALS.
4. WELDING SHALL BE IN ACCORDANCE WITH ASME CODE SECTION IX OR AWS D1.1 AS APPLICABLE
5. WELD CALLOUTS SHOWN ARE TYPICAL FOR ALL LIKE ITEMS.
6. MATERIAL: LEAD PER QQ-L-171E, GR. A OR C
7. LEAD FILL SHALL BE IN ACCORDANCE WITH NUPAC APPROVED LEAD POURING PROCEDURES.
8. STUD, 3/4-10 UNC X 3-1/4
   MATERIAL: ASTM A320, GR L7 OR EQUIVALENT

   NUT, 3/4-10 UNC
   MATERIAL: ASTM A194, GR. 4 OR 7 OR EQUIVALENT

   ALL OTHER FASTENERS SHALL BE SAE GR. 5 OR EQUIVALENT.
9. .105 THICK (12 GA) 304 SST INTERIOR LINER IS OPTIONAL. IF INSTALLED SAID LINER SHALL BE SEAL WELDED ALONG ALL EDGES.
10. OPTIONAL ONE INCH DIAMETER ORIENTATION PIN
11. OPTIONAL 3/4 INCH DIAMETER ORIENTATION PIN
12. LIFTING LUG COVERS SHALL BE PROVIDED AS REQUIRED.
13. NEOPRENE GASKET, 1/4 INCH MINIMUM THICKNESS x 1-1/4 INCH MINIMUM WIDTH.
14. NEOPRENE GASKET, 1/4 INCH MINIMUM THICKNESS x 3/8 INCH MINIMUM WIDTH.
15. 3/4 INCH PIPE. (UTILIZES 1/2 NPT PIPE PLUG)
16. DETAIL C OPTIONAL DRAIN UTILIZES A 1/2 NPT PIPE PLUG WITH A 1-1/4 NPT COVER PLUG.
17. OVER DRAIN OPENING ONLY.
18. CENTER SQUARE BAR OVER DRAIN OPENING, FILLET INNER EDGE (AS SHOWN) AND BOTH ENDS.
19. ONE INCH DIAMETER FASTENER WITH LANYARD ASSEMBLY AND LOCKING PIN.
20. RATCHET BINDER
21. ORIENT RATCHET BINDERS SUCH THAT THE UNIT TIGHTENS AS HANDLE IS PULLED AWAY FROM SHIELD BODY.
22. ONE INCH DIAMETER FASTENER
23. RATCHET BINDER RETAINER
24. OPTIONAL COVER TIE DOWN BRACKETS.
25. IDENTIFICATION PLATE
26. OPTIONAL IDENTIFICATION PLATE
27. LOCKWIRE PRIMARY AND SECONDARY LIDS AS REQUIRED FOR SHIPMENT.
28. PAINT TRANSPORTATION SHIELD PER NUPAC APPROVED PROCEDURES.
29. SCALE; TOP & FRONT VIEW - 1/10
    DETAILS & SECTIONS - 1/2
30. USE 3 LUGS EQUALLY SPACED AS AN OPTION.




REVISIONS
ZONE LTR DESCRIPTION DATE APPROVED
SECTION A-A
ROTATED 90° CW
GASKETS SHOWN UNCOMPRESSED
RATCHET BINDER AND FASTENERS OMITTED
VIEW B-B
DETAIL C (OPTION)
DETAIL C
DETAIL C DRAIN, LOCATION OPTIONAL
ITEM PART NO DESCRIPTION MATERIAL
LIST OF MATERIAL
ASSEMBLY & QUANTITY
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
ANGLES ±
2 PLACE DECIMALS ±
3 PLACE DECIMALS ±
DO NOT SCALE THIS DRAWING
NEXT ASSY USED ON
APPLICATION
NUCLEAR PACKAGING, INC.
TACOMA, WASHINGTON
TRANSPORTATION SHIELD
NUPAC 14D-2.0
DRAWN CHECK ENGR
DWG REL PROD REL
SCALE
REV 0
SHEET 1 OF 1
DWG SIZE D
DWG NO. X-20-215D

3.0 OPERATING PROCEDURES

This chapter generally describes the procedures to be followed in using a NuPac 14D-2.0 Cask.

3.1 Initial Shipment Prior to First Use

3.1.1 The cask shall be mounted to the transportation trailer as follows:

a. If the transportation trailer is the permanent unit the cask shall be secured in accordance with Section 3.4.7 of this procedure utilizing a DOT approved hold down system.

b. If the transportation trailer is for initial delivery only, the cask shall be secured, utilizing standard chain and chain binders normally utilized for heavy loads. The chains shall be secured to the cask hold down lugs.

3.2 Long Term Storage

3.2.1 The casks can be stored for extended period (1 to 3 years) with minimal special preservation. The following precautions should be taken:

a. Ratchet binders and all fasteners should be fully coated with a good quality "automotive chassis" grease.

b. To maintain original finish gloss, the entire cask painted surface may be coated with 2 to 3 layers of any good quality automotive finish wax. The last coat should be allowed to dry without being polished.

c. If required, the cask finish can be further protected from harsh salt spray or chemicals by covering with tarps or storing under other suitable cover.

3.2.2 To maintain the original surface gloss or finish, the interior cavity, painted or stainless steel, may be wax coated as described in 3.2.1.B.

3.2.3 The cask can be prepared for use by standard steam cleaning methods after storage. Ratchet binder threads should be re-greased with good grade automotive chassis lubricant after steam cleaning.

3.3 Lifting

3.3.1 The cask shall always be lifted by the four (4) provided lifting lugs only. The lifting lugs are the vertically oriented lugs on the sides of the casks spaced at 90° around the cask circumference.

3.3.2 All other lifting lugs on the primary and secondary lids shall only be used to lift the lid they are attached to.

3.4 Use of the Cask as a Licensed Type A Container

3.4.1 Removal of the Primary Lid

a. Release the ratchet binder handle from its storage position.

b. Engage the flip block to the sprocket wheel in the direction necessary to loosen the ratchet binder.

c. Loosen the ratchet binder by pulling the handle in the appropriate direction.

d. Remove the retaining pin from the upper ratchet binder pin and then remove the ratchet binder pin.

e. Remove the three (3) primary cask lid lifting lug covers.

f. Using the three (3) primary lifting lugs on the cask lid to accommodate suitable rigging and exercising caution in the handling of the primary cask lid due to possible contamination of the underside of the lid, remove cask lid.

3.4.2 Removal of Secondary Lid

a. Remove the secondary lid holddown fasteners.

b. Remove the secondary lid lifting lug cover(s).

c. Exercising caution due to possible contamination of the underside of the shielding plug, remove the shield plug.

3.4.3 Installation of Primary Lid

a. Prior to installation, inspect gasket for the following:

1. Gasket fully secured to lid sealing surfaces.
2. Gasket not cut, ripped or gouged.
3. Gasket is resilient.
4. Gasket is free of debris, dirt and/or grease.

b. Using the three (3) lifting lugs on the primary lid to accommodate suitable rigging, lift and place lid on cask using alignment guides to assure proper positioning. Take care not to damage gasket.

c. Secure the primary lid to the cask as follows:

1. Install the upper ratchet binder pin through the upper ratchet binder connector and the lid closure lug and install its retaining pin.

2. Tighten the ratchet binder by engaging the flip block to the sprocket wheel and rotate the ratchet binder handle in the direction necessary to tighten the ratchet binder. Tighten to 50 ft-lbs. torque minimum.

Disengage the flip block and rotate and secure the handle to its storage position.

4. Install the three (3) primary cask lid lifting covers.

3.4.4 Installation of Secondary Lid

a. Prior to installation, inspect gasket for the following:

1. Gasket fully secured to lid sealing surface.

2. Gasket not cut, ripped or gouged.

3. Gasket is resilient.

4. Gasket is free of debris, dirt and/or grease.

b. Using the lifting lugs on the secondary lid to accommodate suitable rigging, lift and place lid into the opening on the primary lid. Use alignment pins to assure proper positioning. Take care not to damage gasket.

c. Secure the secondary lid by installing and tightening the fasteners to 100 ft-lbs. torque.

d. Install the secondary lid lifting lug cover(s).

3.4.5 Cask Loading

a. Survey empty cask and the vehicle carrying it to determine the loose and fixed contamination levels. Limitations pertaining to contamination levels shall be determined by regulations imposed on the user by the applicable governing bodies.

b. Inspect cask lid fasteners to assure all are present and undamaged.

c. Check to assure that cask lid (primary and secondary) lifting lug covers are with the cask.

d. Remove primary lid in accordance with Section 3.4.1.

e. Remove secondary lid in accordance with Section 3.4.2.

f. Inspect secondary lid holddown studs for damage.

g. Inspect interior of cask for standing water.

NOTE: Water must be removed prior to shipment (see Section 3.5).

h. Inspect interior of cask for obstructions to loading.

i. Inspect interior of cask for defects which might affect the cask integrity or shielding afforded by the cask.

j. If loading drums on pallets, proceed as follows: follows:

1. Load drums on each pallet.

2. Place drums within guides provided on the pallet deck to facilitate proper orientation.

3. For maximum shielding, load higher dose rate drums in the center position and the positions toward the front and rear of the trailer.

4. The lifting sling remains attached to the pallet at all times.

5. B. loading the center drum first and then three drums on one side, the sling can be placed over the loaded drums while the remaining three are loaded. This technique prevents damage to the sling.

6. The sling assembly should be placed around the drums in such a way to prevent damage to the sling.

7. The sling assembly should be inspected at each loading for damage and general condition.

8. Place loaded pallet into cask, assuring that pallet slings are not caught along side or under the pallet.

9. Place sling around or along side drums to prevent pinching or damage to the sling by the lids or second/top pallet in the cask of the 14 drum cask.

10. Load a second pallet in the same manner described in #1 through #9.

11. Inspect lid and gaskets, install cask lids and secure as described in Section 3.4.3 for the primary lid and Section 3.4.4 for the secondary lid.

k. If loading preloaded liners, proceed as follows:

1. If necessary, the cask may be removed from the trailer in accordance with Section 3.4.6.

2. Assure all lids, plugs or caps are installed on liner.

3. Using the lifting slings provided, place liner into the cask.

4. Install shims/shoring between liner and cask as necessary to secure in position.

5. Inspect lid gaskets, installed cask lids and secure as described in Section 3.4.3 for the primary lid and Section 3.4.4 for the secondary lid.

L. If loading into liner inside cask, proceed as follows:

1. If necessary, the cask may be removed from the trailer in accordance with Section 3.4.6.

2. Using the slings provided, place liner in the cask.

3. Install shims/shoring between liner and cask as necessary to secure in position.

4. Inspect gaskets, install and secure primary lid as described in Section 3.4.3.

5. Do not install secondary lid at this time.

6. Load the waste into the liner through the secondary lid opening.

7. Install the liner lid, plugs, or caps onto the liner.

8. Inspect gaskets, install and secure secondary lid as described in Section 3.4.4.

m. Install tamper-proof seals.

3.4.6 Cask Removal from Trailer

a. Loosen ratchet binders/turnbuckles as necessary to remove pins from shackles at cask end of tiedown system.

b. Remove pins from shackles.

c. Using the four (4) cask lifting lugs and suitable rigging lift cask off trailer and place cask in proper position for loading.

NOTE: Do not use cask lid lifting lugs to lift the cask.

3.4.7 Cask Installation on Trailer

a. Using the four (4) cask lift lugs and suitable rigging lift cask and place cask in proper position within the shear blocks provided on the trailer.

NOTE: Do not use cask lid lifting lugs to lift the cask.

b. Inspect tiedown lugs and shackles on cask and trailer for cracks and wear which would affect their strength.

c. Inspect tiedown cables to assure they are not loose, or damaged (crimped, frayed, etc.).

d. Inspect tiedown ratchets/turnbuckles to assure they are in proper working condition.

e. Install shackles through the end of the tie-down cables and attach to cask tiedown lugs by screwing pin through shackle and hole in lug.

f. Tighten ratchet binders/turnbuckles as necessary to secure cask on trailer.

3.4.8 Preparation of Cask for Shipment as Type A Container

a. Perform radiation surveys of cask and vehicle and complete the necessary shipping papers, certifications, and pre-release checklist, or site equivalent.

b. Placard vehicle and label cask as necessary.

3.4.9 Receiving a Loaded Cask

The receiver, carrier and shipper are to follow the instructions of 10 CFR 20.205 when a package is delivered. These instructions include monitoring the external surface of the cask for radioactive contamination.

3.5 Containment Penetration Seals

Installation of pipe plugs used to seal the drain line is to be done using a pipe joint sealing compound. Plugs are to be tightened to 20 ft-lbs. torque.