71-9151

PDR

Return to 39655

NUS PROCESS SERVICES CORPORATION

May 7, 1985

Mr. Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle & Material Safety, NMSS
US Nuclear Regulatory Commission
Washington, DC 20555

'85 MAY -8 A10:44

Re: USNRC Letter dated March 11, 1985,
Docket Number 71-9151

Dear Mr. MacDonald:

This letter is in response to and transmits the information requested in the above referenced letter. This letter and attachments are intended to supplement NUS Process Services' (NUSPSC) application dated December 7, 1984, as supplemented January 11, 1985 requesting amendment to the NUS 14-170 Series 1 radioactive material shipping package.

In response to the requested information, NUSPSC has revised the Secondary Lid Analysis to include the same lid bolt strength and lid bolt torquing requirement that was used for the identical package lid design approved by Certificate of Compliance No. 9159.

Please find attached the revised Secondary Lid Analysis, Rev. 1, and modified procedures that support the maintenance and operations of the NUS 14-170 cask (Certificate of Compliance No. 9151). Should you have any additional questions, I shall be pleased to respond.

Sincerely,

W. M. Hipsher
Manager
Transportation Services

WMH:pw

cc: S. McCoy - NUSPSC
R. Voit - NUSPSC
G. Antonucci - NUSED

Attachments: Secondary Lid Analysis (8 copies)
Procedure WM-014, "Operating Instructions for Loading and Unloading the NUS 14-170 Series 1 Package" (8 copies)
Procedure WM-012, "NUS 14-170 Series 1 Maintenance" (8 copies)
Procedure WM-011, "Soap Bubble Leak Test NUSPSC Type A Shipping Cask" (8 copies)

DOCKETED USNRC MAY 8 1985 NMSS MAIL SECTION DOCKET CLERK

25221

A Westinghouse Company
1501 KEY ROAD, COLUMBIA, S.C. 29201 (803) 256-4355

FEE EXEMPT added info

NUS CORPORATION

DATE 4/25/85

CLIENT NUS PSC FILE NO. 8916-CD-01, Rev. 1 BY F. Daneshgar

SUBJECT NUS 14-170 Series 1 Package Checked By H. Eckert

SECONDARY LID ANALYSIS

The purpose of this analysis is to provide the additional information requested by the USNRC in their letter of March 11, 1985. The specific request is as follows:

> The justification for increasing the secondary lid from a 15.75-inch diameter to 28.75-inch diameter is primarily based on a comparison with the package designs approved by Certificate of Compliance No. 9159. The comparison provided is not acceptable because differences in the lid bolt strength and lid bolt torquing requirements were not considered. This could result in decreased safety margins. In making a comparison, you should show that the safety margin for the applied method is at least equal to that approved. Alternatively, you may provide a detailed analysis of the adequacy of your closure design.

With respect to the bolt strength, the yield stress of the A-193 Grade B7 bolt material used in the NUS 14-170 Series 1 Package is 105,000 psi. This is the same bolt yield stress that was used in the package designs approved by Certificate of Compliance No. 9159. Our calculations have been revised to reflect the minimum specified bolt yield stress of 105,000 psi.

Our Specification No. WM-014, "Operating Instructions for Loading and Unloading the NUS 14-170 Series 1 Package" has been revised to specify a 100 ft.-lb. lid bolt torquing requirement. This torque is the same as that specified for the package designs approved by Certificate of Compliance No. 9159.

With these two revisions to our calculations, and use of our impact deceleration of 26.0 g rather than the 33.9 g value used in the design approved by Certificate of Conformance No. 9159, the safety margin is 1.03. This margin is greater than the margin of 0.63 approved by Certificate of Compliance No. 9159. This calculation therefore provides the additional justification as requested by the USNRC for increasing the size of the secondary lid.

RECORD OF REVISIONS

REVISION NUMBER	ISSUE DATE	REVISION BY	CHECKED BY	PAGES REVISED	DESCRIPTION OF CHANGE
0	1/9/85	—	—	ORIGINAL ISSUE	—
1	4/25/85	FD	MKP	REVISED PAGES: 2, 6, 7 OF 10. ADDED PAGE i.	REVISED THE PRELOAD TORQUE & ALLOWABLE STRENGTH OF STUDS.

CLIENT NUS PROC SERV FILE NO 8916-CD-01 BY FD

SUBJECT NUS-14-170 SERIES 1 CASK Checked By ISTAR, ATA

CLIENT: NUS PROCESS SERVICES

ANALYSIS FILE NUMBER: 8916-CD-01

ANALYSIS TITLE: NUS-14-170 SERIES 1 CASK SECONDARY LID.

AUTHOR: F. DANESH CAK

PURPOSE OF ANALYSIS: TO DEMONSTRATE ACCEPTABILITY OF OPTIONAL 29" DIA. SECONDARY LID BASED ON STRUCTURAL REQUIREMENTS OF 10 CFR 71 (REF. 1)

METHOD OF ANALYSIS: HAND CALCULATIONS ARE PERFORMED FOR BENDING STRESS IN THE LID, FOR THE STUDS LOAD CAPACITY & LIFTING LUGS CAPACITY.

INPUT INFORMATION: INPUTS ALONG WITH THEIR SOURCE ARE IDENTIFIED IN THE DETAILED CALCULATIONS.

MAJOR ASSUMPTIONS: REALISTIC ASSUMPTIONS ARE CONTAINED IN THE BODY OF THE DETAILED CALCULATIONS SECTION.

REFERENCES:

1) DOCUMENT Nº WM-014 REV.F, "OPERATING INSTRUCTIONS FOR LOADING AND UNLOADING THE NUS-14-170 SERIES 1 CASKS. REV.1 FD MKF

2) CERTIFICATE Nº 9151 – REVISION Nº 4 – DOCKET Nº 71-9151, "CERTIFICATE OF COMPLIANCE FOR RADIOACTIVE MATERIALS PACKAGES".

3) "SAFETY ANALYSIS REPORT FOR THE HN-100 SERIES 3 RADWASTE SHIPPING CASK REV.5", DOCUMENT Nº STD-R-02-001 BY NITTMAN NUCLEAR & DEVELOPMENT CORPORATION.

4) ROARK AND YOUNG, "FORMULAS FOR STRESS AND STRAIN", 5TH EDITION, MCGRAW HILL COMPANY.

5 a) NUS DRAWING Nº 8916-M-2001, REV C
5 b) " 8916-M-2002, REV B
5 c) " 8916-M-2003, REV B
5 d) " 8916-M-2004, REV A
5 e) " 8916-M-2005, REV A
5 f) " 8916-M-2006, REV A
"NUS-14-170 SERIES 1 TRANSPORTATION CASKS".

6) J.E. SHIGLEY, "MECHANICAL ENGINEERING DESIGN", 3TH EDITION, MCGRAW-HILL CO.

7) CODE OF FEDERAL REGULATIONS, TITLE 10, PART 71, (LATEST EDITION).

8) ASME CODE SECTION III, APPENDIX I, TABLE I-2.1, 1983 ED.

DETAILED CALCULATIONS

ASSUMING A "LOOSE" PAYLOAD, AN EQUIVALENT PRESSURE LOAD AGAINST THE INSIDE OF THE SECONDARY LID CAN BE CALCULATED USING THE PAYLOAD DENSITY, PAYLOAD DEPTH AND IMPACT ACCELERATION. THEREFORE THE PAYLOAD WEIGHT REACTED BY THE LID IS:

$$W_p = (H_p)\left(\frac{\pi}{4}\right)(D_{S.L.}^2)(\rho_p)$$

WHERE:

H_p = PAYLOAD HEIGHT

$D_{S.L.}$ = DIA. OF SECONDARY LID (INSIDE OF LINER)

ρ_p = DENSITY OF PAYLOAD

$H_p = 73.63''$ (CONSERVATIVE) (REF. 5b)

$D_{S.L.} = 29''$ (REF. 5f, SECTION "A-A")

$D_{P.L} = 75.25''$ (REF. 5f, SECTION "A-A")

$\rho_p = \frac{W_{PAYLOAD}}{V_{PAYLOAD}} = \frac{19205\ lb\ (REF.2)}{V_{PAYLOAD}}$

$V_{PAYLOAD} = \frac{\pi}{4}\left(\frac{75.25''}{12}\right)^2 (13.63''/12) = 189.5\ ft^3$ = PAYLOAD VOLUME

(13.63" = HEIGHT OF THE PAYLOAD (REF. 5b))

$\therefore \rho_p = \frac{19205}{189.5} = 101.35\ \frac{lb_m}{ft^3}$

$W_p = 73.63\left(\frac{\pi}{4}\right)(29'')^2(101.35)\left(\frac{1}{1728\ in^3/ft^3}\right)$

$= 2853\ lb$

SECONDARY LID WEIGHT IS:

$$W_L = \rho_{MATERIAL\ (LID)}\ (V_{LID})$$

CONTINUED ON NEXT PAGE →

$$W_L = .284 \frac{lb}{ft^3}\left[\frac{\pi}{4}(28.75)^2(2) + \frac{\pi}{4}(30.75)^2(2) + \frac{\pi}{4}(35.75)^2(1)\right]$$

SECONDARY LID PLATE DIA. TAKEN FROM REF. 5f.

$= 1076$ lb

USE 1200 lb TO CONSIDER WEIGHT OF EXTRA COMPONENTS LIKE LUGS & BOLTS & ETC.

∴ TOTAL FORCE REACTED BY THE SECONDARY LID IS:

$$F_T = (W_P + W_L)\, a_g \cos\alpha$$

WHERE a_g IS THE IMPACT ACCELERATION & α IS THE IMPACT ANGLE.

ACCORDING TO REF. 3

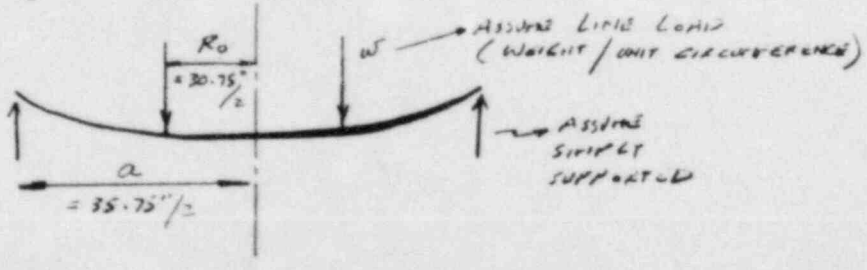
$a_g = 26\,g$

$\alpha = 45°$ (WORST CASE)

∴ $F_T = (2853\ lb + 1200\ lb)(26 \times \cos 45°)$

$= 74514$ lb

MAXIMUM BENDING STRESS IN THE LID CAN BE FOUND ASSUMING A LINE LOAD ON THE 1" PLATE AT THE OUTER DIAMETER OF THE 2" PLATE DIRECTLY BELOW (DIA = 30.75", REF. 5f). ASSUME THE OUTER EDGE OF THE 1" PLATE IS SIMPLY SUPPORTED (DIA = 35.75").



THE MAXIMUM MOMENT IN THE PLATE IS GIVEN BY REF. 4, TABLE 24, CASE 9a AS:

$$M_c = w\, a\, L_q$$

WHERE

$$L_q = \frac{R_o}{a}\left\{\frac{1+\nu}{2}\ln\frac{a}{R_o} + \frac{1-\nu}{4}\left[1-\left(\frac{R_o}{a}\right)^2\right]\right\}$$

$$\therefore\ L_q = \frac{30.75/2}{35.75/2}\left\{\frac{1+.3}{2}\ln\frac{35.75/2}{30.75/2} + \frac{1-.3}{4}\left[1-\left(\frac{30.75/2}{35.75/2}\right)^2\right]\right\}$$

$$= .1234$$

$$\therefore\ M_c = \frac{74514\ \text{lb}}{\pi(30.75")}(35.75/2)(.1234) = 1702\ \frac{\text{in-lb}}{\text{in}}$$

PLATE BENDING STRESS IS GIVEN BY:

$$f_b = \frac{6M_c}{t^2} \qquad \text{(REF. 4)}$$

$$= \frac{6(1702)}{1^2} = 10212\ \text{psi}$$

THEREFORE THE MARGIN OF SAFETY FOR THE PLATE IS:

$$M.S. = \frac{f_Y}{f_b} - 1$$

f_Y (FOR LID MATERIAL OF ASI6 CR 70) (REF. 5d)

$= 38{,}000$ psi (REF. 8)

$$\therefore\ M.S. = \frac{38{,}000}{10212} - 1 = +2.72$$

OK

CHECK THE STRESSES IN THE STUDS

THE STRESS IN THE STUD (REF. 5d), CONSISTS OF TWO PARTS:

1) DUE TO PRELOAD
2) DUE TO IMPACT LOADING

THE PRELOAD FORCE ON A STUD CAN BE ESTIMATED USING EQUATION 6-16 FROM REF. 6:

$$T = 0.20 F_b d$$

WHERE: T = BOLT TORQUE = 100 ft-lbs (REF. 1)

REV. 1 FD MPF

F_b = BOLT PRELOAD

d = BOLT DIAMETER (3/4")

$$\therefore F_{b_p} = \frac{T}{0.20(d)} = \frac{100 \text{ ft-lb } (12 \text{ in/ft})}{0.20(.75")} = 8000 \text{ lb}$$

REV. 1 FD MPF

IMPACT FORCE ON A STUD IS:

$$F_{b_i} = \frac{74514 \text{ lb (TOTAL IMPACT FORCE)}}{8 \text{ (STUDS)}} = 9315 \text{ lb}$$

SINCE THE GASKET "STIFFNESS" IS MUCH SMALLER THAN THE STUD "STIFFNESS", RATIO OF $\frac{K_b}{K_m + K_b}$ OF EQUATION 6-12 FROM REF. 6, APPROACHES UNITY; THEREFORE THE TENSION IN THE STUD IS ADDITION OF PRELOAD & IMPACT FORCES.

REV. 1 FD MPF

$$\therefore F_{b_{TOTAL}} = F_{b_p} + F_{b_i} = 8000 + 9315 = 17315 \text{ lb}$$

STUD LOAD CAPACITY IS FOUND NEXT:

STUDS ARE $\frac{3}{4}$"-10 UNC ASTM A 193 GRADE B-7, (Ref 5c)
THEREFORE FOR ASTM A 193 GRADE B-7, THE MINIMUM YIELD STRENGTH IS:

FOR $\leq 2\frac{1}{2}$" ϕ BOLTS: f_y = 105,000 PSI (REF. 8, TABLE I-10.3 & I-7.3)

REV. 1 FD

TO AVOID A PERMANENT SET OF THE BOLT (STUD):

$\therefore$ STUD CAPACITY = $f_y \cdot A_{ROOT}$ (REF. 6)

= 105,000 (.334) → TENSILE AREA.

= 35070 lbs

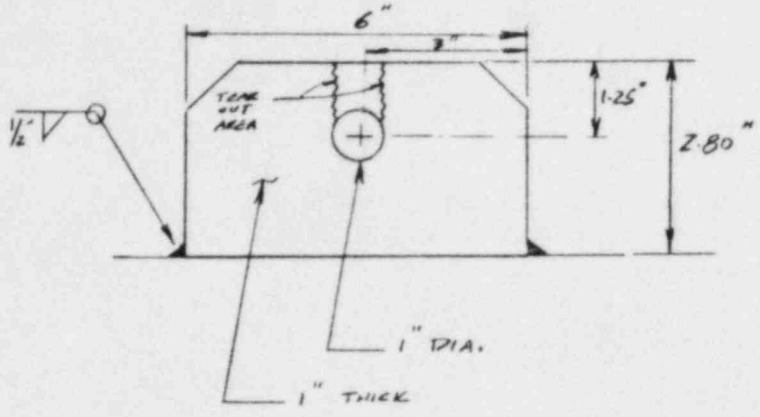
THEREFORE, THE MARGIN OF SAFETY FOR THE STUDS IS:

$$M.S. = \frac{\text{STUD CAPACITY}}{F_{b_{TOTAL}}} - 1$$

$$= \frac{35070}{17315} - 1 = \underline{\underline{+1.03}}$$

$\therefore$ O.K.

ANALYSIS OF SECONDARY LID LIFTING LUG



MATERIAL A-516 GRADE 70 (REF. 6d)

a) NORMAL LIFTING CONDITION (LIFTING THE SECONDARY LID)

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

ACCORDING TO 10 CFR 71, THE STRESSES DUE TO LIFTING A PACKAGE OF 3 TIMES ITS WEIGHT SHALL BE BELOW YIELD.

TEAR OUT

$$\text{AREA} = 2\left[1.25" - .5"\right](1" \text{ TH.})$$
$$= 1.5 \text{ in}^2$$

$$\text{STRESS} = 3(1200) / 1.5 \text{ in}^2 = 2400 \text{ psi}$$

ALLOWABLE STRESS = .577 (38,000 psi) (REF. 3, PAGE 4)
= 21926 psi

$$\therefore \text{M.S.} = \frac{21926}{2400} - 1 = 8.13$$

$\therefore$ OK

TENSION

$AREA = (6" - 1" \times 1" TH) = 5\ in^2$

$STRESS = 3(1200\ lb) / 5\ in^2 = 720\ psi$

$ALLOWABLE\ STRESS = F_Y = 38{,}000\ psi$ (REF. 3, PAGE 4)

$M.S. = \frac{38000}{720} - 1 = 51.8$

∴ OK

LUG WELD

$\frac{1}{2}"$ FILLET WELD WITH ALLOWABLE OF 21,000 psi (REF. 3, PAGE 4)

$AREA\ OF\ WELD = (6" + 6" + 1" + 1")(.707)(.5")$

$= 4.949\ in^2$

$STRESS\ IN\ WELD = \frac{3(1200\ lb)}{4.949} = 728\ psi$

$\therefore M.S. = \frac{21000}{728} - 1 = 27.8$

OK

b) EXCESSIVE LOADING CONDITION (LIFTING THE CASK BY THE SECONDARY LUG)

CASK WEIGHT:

TOTAL = 53005 lb (REF. 2)

NOTE: IT IS INTENDED TO SHOW THAT UNDER EXCESSIVE LOAD CONDITION (MENTIONED ABOVE), THE LUG WILL →

CONTINUED NEXT PAGE

FAIL BEFORE THE SECONDARY LID (LID PLATE & STUDS) DO.

MAX. LOAD THAT "LUG" CAN TAKE BEFORE TEAR OUT = $\frac{21926\ (1.5)}{3}$ = 10963 lb

MAX. LOAD THAT "LUG" CAN TAKE BEFORE FAILURE IN TENSION = $\frac{38000\ (5)}{3}$ = 63333 lb

MAX. LOAD THAT LUG WELD CAN TAKE = $\frac{21000\ (4.949)}{3}$ = 34643 lb

IN THE PREVIOUS PAGES CALCULATIONS, IT WAS SHOWN THE SECONDARY LID & THE 3/4" STUDS ARE ACCEPTABLE FOR A MINIMUM FORCE OF 74514 lb & THE ABOVE CALCULATIONS SHOW THAT THE SECONDARY LUG WILL FAIL FOR FORCES GREATER THAN 10963 lb; THEREFORE IT IS CONCLUDED THAT UNDER EXCESSIVE LOAD CONDITION (LIFTING THE CASK BY THE USE OF SECONDARY LUG), THE STRUCTURAL INTEGRITY OF THE LID ITSELF IS ASSURED & THE ONLY THE LUG WILL FAIL.