71-9270

NAC INTERNATIONAL

Atlanta Corporate Headquarters
655 Engineering Drive
Norcross, Georgia 30092
770-447-1144
Fax 770-447-1797
www.nacintl.com

March 30, 2001

U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Attn: Document Control Desk

Subject: Docket No. 71-9270 (TAC No. L22452)

Submittal of the NAC Responses to the NRC Request for Additional Information (RAI) on the UMS® Universal Transport Cask Application, Chapter 2 Structural Evaluation

References:
1. Request for Additional Information for the UMS® Universal Transport System, USNRC, August 30, 1999
2. Submittal of NAC-UMS® Universal Transport System Safety Analysis Report, Revision UMST-00A, NAC International, June 29, 2000
3. Submittal of Supplemental Information for the NAC-UMS® Universal Transport System Safety Analysis Report, Revision UMST-00B, NAC International, August 8, 2000
4. NAC International Response on Regulatory Review Issues, NAC International, October 26, 2000
5. NRC/NAC Meeting Regarding the NAC-UMS® Transport Cask Application, January 12, 2001
6. Submittal of the NAC Responses to the NRC Request for Additional Information, not including Chapter 2 Structural Evaluation, Revision UMST-01A, NAC International, March 14, 2001

NAC International (NAC) herewith submits ten copies of the Chapter 2, Structural Evaluation, responses to Reference 1, U.S. NRC Request for Additional Information for the NAC-UMS® Transport System Safety Analysis Report (SAR). These responses include the results of the quarter-scale model side drop test that was performed March 13, 2001, at Sandia National Laboratory. Note that the RAI Responses for Chapters 1, 3, 4, 5, 6, 7, 8 and Dual-Purpose Canister were previously provided to the NRC in Reference 6.

This submittal includes the RAI comments and NAC's responses presented in the standard NAC RAI response format, followed by the associated SAR changed pages, which are designated as Revision UMST-01B of the UMS® Universal Transport Cask SAR. NOTE: The enclosed SAR changed pages are to be inserted as replacement or new additional pages, as applicable, in the binders containing the complete SAR that were provided in Reference 2. Those complete SAR binders should already have the SAR changed pages provided in Reference 3 and Reference 6 inserted. The List of Effective Pages provided in this submittal can be used to ensure that the correct page revisions are incorporated in the SAR binders.

NMSS01 PROP

ED20010449

The changed pages have been prepared in accordance with the following conventions:

- Revision indicators (shading and revision bars) are used to highlight changes. Shading indicates a revision from SAR Revision 0; while a revision bar indicates a change in the SAR from a previous revision, other than Revision 0.
- The changed pages for this submittal are designated as Revision UMST-01B to provide a unique identification of the pages and changes.
- All of the pages in the List of Effective Pages are designated Revision UMST-01B and no revision bars are used on those pages.

This submittal includes the drawings of the 2001 Drop Confirmation 1/4-Scale Cask Body and impact limiters:

790-302	Lower Impact Limiter, 1/4 Scale Model	NAC Proprietary Information
790-303	Upper Impact Limiter, 1/4 Scale Model	NAC Proprietary Information
790-308	1/4 Scale Cask Body, 2001 Drop Confirmation, NAC-UMS®	
790-309	Drop Test Assembly, 2001 Drop Confirmation, NAC-UMS®	

The scale model impact limiter drawings provided in this submittal are NAC Proprietary Information. Three sets of the impact limiter drawings are provided in appropriately marked separate packaging. The executed Proprietary Information Affidavit is attached. The NAC Proprietary Information included in this submittal are Drawings 790-302 and 790-303, described above. These drawings provide design details of NAC's proprietary impact limiter design.

Drawing 790-508 has been changed to incorporate a revision to Item 4 Retaining Rod to eliminate the 0.3 x 1.1 diameter undercut, which acts as a stress-riser at the top of the threads at the interior end of the rod. Since there is no functional or fabrication requirement for the undercut, and based on the side drop test results, the tensile strength of the retaining rod is enhanced by the change. Minor revisions have been incorporated on Drawings 790-582, 790-584, 790-585, 790-592, 790-595, 790-611, and 790-612 based upon ongoing fabrication of the components. The drawing changes correct fabrication details and/or improve the fabricability of the components. The drawing changes do not affect the form, fit, or function of the components and they do not change the component designs, as analyzed in the SAR. Descriptions of the NAC-UMS® Transport drawing changes are included in Attachment 1.

NAC INTERNATIONAL

If you have any comments or questions, please contact me on my direct line at (678) 328-1321.

Sincerely,

T C Thompson

Thomas C. Thompson
Director, Licensing
Engineering & Design Services

Attachment

Enclosure

cc: T. Williamson (MY)
P. Plante (MY)

NAC INTERNATIONAL

AFFIDAVIT

IN SUPPORT OF PROPRIETARY INFORMATION CONTAINED IN TWO DESIGN DRAWINGS SUBMITTED IN SUPPORT OF THE NAC INTERNATIONAL RESPONSES TO AN NRC REQUEST FOR ADDITIONAL INFORMATION ON THE NAC-UMS® UNIVERSAL TRANSPORT CASK APPLICATION

State of Georgia, County of Gwinnett

Willington J. Lee (Affiant), Vice President & Chief Engineer of NAC International, hereinafter referred to as NAC, at 655 Engineering Drive, Norcross, Georgia 30092, being duly sworn, deposes and says that:

1. Affiant is personally familiar with the trade secrets and privileged information contained in the two design drawings being submitted in support of the NAC responses to a Nuclear Regulatory Commission Request for Additional Information on the NAC-UMS® Universal Transport Cask application. Affiant requests that the Nuclear Regulatory Commission, pursuant to Chapter 10 of the Code of Federal Regulations, Part 2.790 (10 CFR 2.790) "Public Inspections, Exemptions, Request for Withholding," withhold the information contained within the drawings being submitted as part of the subject application, hereafter referred to as the Proprietary Material, from public disclosure.

2. This information has been and is held in confidence by NAC.

3. The information contained within the proprietary material is the result of design calculations including component design details and critical dimensions that were developed by NAC. This type of information is held in confidence based on the significant commercial investment of time and money expended in its development.

4. The Proprietary material being transmitted to the Nuclear Regulatory Commission in confidence includes NAC Drawings 790-302, Revision 3, and 790-303, Revision 6.

5. The information that is being claimed as trade secret and privileged information has not been and is not available in public sources.

NAC INTERNATIONAL

AFFIDAVIT
(continued)

6. NAC has invested a considerable amount of time, engineering labor, and money in the development of these drawings and design details. Public disclosure of this information would cause substantial harm to the competitive position of NAC. Others seeking to develop similar analysis would have to make similar investments to develop the information on their own as long as the information is not disclosed to the public.

Willington J. Lee
Vice President & Chief Engineer
Engineering & Design Services
NAC International

Subscribed and sworn to before me this 30th day of March 2001.

Notary Public in and for the
County of Cobb
State of Georgia

My commission expires the 4th day of November, 2002

Notary Public, Cobb County, Georgia
My Commission Expires Nov. 4, 2002

NAC INTERNATIONAL

ATTACHMENT 1

UMS® Universal Transport Cask Drawing Changes

UMS® UNIVERSAL TRANSPORT CASK DRAWING CHANGES

Drawing 790-508, Revision 2 — Misc. Details, Transport Cask, NAC-UMS®

- Remove under cut on Retaining Rod, Sheet 1, Zone B-8
- Update title block

Drawing 790-582, Revision 7 — Shell Weldment Canister NAC-UMS®

- Item 7, Zone A/B-8, Reduce 1.2 to .8
- Item 7 and Item 6, Zone D-1, Move weld callout from 1.0 side to 2.5 side

Drawing 790-584, Revision 11 — Details, Canister, NAC-UMS

- Sheet 3 of 3, for lid support ring, Item 6, remove the 0.38" bevel and show the lid support ring as a square bar
- Sheet 3 of 3, in Zone B-6, delete Detail F-F
- Sheet 3 of 3, in Zone D-5/6, delete the dashed circle and the words "See Detail F-F"
- Sheet 3 of 3, in Zone C-7, add Delta Note 8 next to Delta Note 6
- Sheet 1 of 3, add Delta Note 8 to read "Weld preparation shall be determined by the fabricator based upon the weld process used. See Drawing 790-585 and 790-612 for effective throat size of weld"
- Revise Sheet 1 of 3, Note 2 to read. . . "Engrave delta.5" per side and .03" deep, not to infringe on the weld bevel, and fill with weather resistant black paint
- Sheet 2 of 3, revise Detail C-C, to reflect changed diameter of weld prep, diameter of backing bar groove, and diameter of material below backing bar groove per attached sketch
- Sheet 2 of 3, revise Structural Lid, to change the diameter from "65.5" to "65.1"
- Sheet 3 of 3, revise Backing Ring, to change diameter from "64.8" to "64.4"
- Sheet 1 of 3, add Delta Note 9 to read: "Minimum of 0.125 of material is required to be underneath bolt hole"
- Sheet 2 of 3, Section F-6, add Delta Note 9 callout at structural lid bolt-hole callout

Drawing 790-585, Revision 8 — Transportable Storage Canister, (TSC) NAC-UMS

- Sheet 1 of 2, Zone F-5, change the 5/16" partial pen with 1/8" fillet weld symbol to a 1/8" effective throat weld all around, except for key slot region, geometry optional
- Change Delta Note 9 to read as follows: "At the option of the user, Stainless Steel (ASTM/ASME A/SA 240 Type 304/304L) Shims of appropriate thickness may be used in the welding of the shield lid (Item 17) to the shell weldment (Item 1 – 5)"
- Revise welding symbol, drawing Zone F-5, Sheet 1, to delete 1/8" square groove portion of the symbol

Drawing 790-592, Revision 5 — Top Weldment, Fuel Basket, 24 Element PWR NAC-UMS®

- Drawing Zone E5 dimension is) .2" typ., was) .4" typ.
- Add chamfer to Items 3, 4, and 7, at interfaces with Item 2, with the following call-out in Section A-A: "45° ± 5° x .3"

UMS® UNIVERSAL TRANSPORT CASK DRAWING CHANGES

Drawing 790-595, Revision 5 — Fuel Basket Assembly, 24 Element PWR, NAC-UMS®

- Add the second sentence to Note 3: "This dimension applies to the gap between the tallest fuel tube and the top weldment only
- Add 45° x 3 chamfer to graphics for Items 2, 17, and 18, that was added per DCR No.: 790-592-4B

Drawing 790-611, Revision 3 — GTCC Waste Basket, Maine Yankee, NAC-UMS®

- Add full penetration seam weld to Item 8
- Item 9 – Separator plate – replace six drain holes currently shown with nine 1-inch diameter drain holes in the same pattern as shown for Item 2 – Bottom plate
- Sheet 1 of 2, delete Item 11 and change graphics and overall dimensions in assembly-99 accordingly
- Sheet 2 of 2, Zone 7A, replace ASSY 96 with attached revised drawing
- Change Item 5 material spec to ASTM A249/A213
- Add note for allowing Items 1, 7, and 14 to be fabricated from multiple pieces utilizing full penetration welds
- Sheet 2, Zone F6, add optional weld geometry for double V-Groove weld for Items 1 and 7
- Add Delta Note 5 symbol to weld, Zone E3, Sheet 2
- Add Delta Note 5, Sheet 1 as follows: "Weld size between Item 1 and Item 3, in area of Item 5, guide tube, may be reduced as needed to allow Item 5 to fit. For the top Item 1, topside weld, weld between Item 1 and Item 3 will not be all around where junction of Item 13 occurs
- Add additional holes to Assembly 97 per attached sketch
- Delete Item 13
- Add groove to top disk section (Item 1) in the same orientation as that which was in the original Item 13. This groove is to be continuous through the thickness of the disk.
- Revise Delta Note 6, Sheet 1 as follows: "Weld size between Item 1 and Item 3, in area of Item 5, guide tube, may be reduced as needed to allow Item 5 to fit (see DCR 1B)
- Revise Delta Note 5, Sheet 1 to add: "Weld between Item 1 and Item 3, may transition to a seal weld in the area of the notches at the base of Item #3 (see DCR 1D for the first sentence)
- Zone D7, Sheet 2, change 6X 60 degrees to have +/- 5 degree tolerance
- Zone E2, Sheet 2, change 12.0 to be 12.0 +/- .5

UMS® UNIVERSAL TRANSPORT CASK DRAWING CHANGES

Drawing 790-612, Revision 3 — GTCC Waste Canister, Maine Yankee, NAC-UMS®

- Sheet 1 of 2, BOM, add Item 15: Shield Cover (Drawing 790-611-96), Qty. 1
- Sheet 1 of 2, BOM add Item 16: Hex Head Bolt, St. Stl, Coml grade, 1-8 UNC-2Ax3 lg., Qty: 3
- Add Delta Note 15: "Attach Item 15 (Shield Cover) to Item 9 (Shield Lid Assy.) using Item 16 (Hex Head Bolt) prior to installation of Shield Assembly (Item 9 – Reference Note 4). Torque Item 16 to 120 Ft Lb. +/- 20 Ft Lb."
- Add Delta Note 15 to Items 9, 15, and 16
- Page 1 of 2, Zone 5C, remove reference to .8 min gap
- Page 1 of 2, Zone 5E/D, revise section detail to reflect attachment of Item 15 (Shield Cover) to Item 9 (Shield Lid Assy.)
- Page 2 of 2, Zone 3B/C, remove .8 dimension and revise section detail to reflect attachment of Item 15 (Shield Cover) to Item 9 (Shield Lid Assy.)
- BOM Item 9, Shield Lid Assembly, change from drawing 790-584-099 to 790-584-098
- Delete the 1/8" butt weld for the key slot region in Zone F-4/5 on Sheet 1
- Revise the size of the partial penetration groove weld for the lid support ring (Item 8) to the key (Item 13) in Zone C-5/6 on Sheet 2 IS) (7/16"), WAS) (3/8")
- Sheet 1 of 2, Zone F-5, change the 5/16" partial pen with 1/8" fillet weld symbol to a 1/8" effective throat weld all around, except for key slot region, geometry optional
- Add a 1/16" fillet on farside 2" every 12" to above the weld
- Increase the length of Item 13 to 8.5", 2 places, Sheet 2, Zone C-7, hard dimension, Zone B-3, reference dimension
- Change Delta Note 14 to read: "At the option of the user, Stainless Steel (ASTM/ASME A/SA 240 Type 304/304L) Shims of appropriate thickness may be used in the welding of the shield lid (Item 9) to shell (Item 3)

EA790-SAR-001

DOCKET NO. 71-9270

UMS®

UNIVERSAL MPC SYSTEM®

SAFETY ANALYSIS REPORT

for the

UMS® Universal Transport Cask

MARCH 2001 UMST-01B

VOLUME 1 OF 2

NAC INTERNATIONAL

NAC-UMS
Docket # 71-9270
TAC # L22452

NAC INTERNATIONAL

RESPONSE TO THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

REQUEST FOR ADDITIONAL INFORMATION

(RAI-1 AUGUST 30, 1999)

CHAPTER 2 STRUCTURAL

NAC UNIVERSAL TRANSPORT SYSTEM (NAC-UMS®)

(TAC. NO. L22452, DOCKET NO. 71-9270)

MARCH 2001

TABLE OF CONTENTS FOR NAC-UMST RAI-1 RESPONSES*

*Note: Chapter 1 (General Information), Chapter 3 (Thermal), Chapter 4 (Containment), Chapter 5 (Shielding), Chapter 6 (Criticality), Chapter 7 (Operating Procedures), Chapter 8 (Acceptance Tests and Maintenance Program) and Dual-Purpose Canister RAI responses were provided to the NRC on March 14, 2001.

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.1 Structural Design

2-1 Provide a summary description of the codes and standards and their exceptions applicable to the structural design of the GTCC waste canister and basket.

Complete and accurate information on the GTCC waste basket should also be presented, per Section 71.7(a).

NAC Response

The GTCC waste canister is constructed to the same codes and standards as the canister for spent fuel. The GTCC waste canister has the same external dimensions and is closed and sealed using the same procedures as for the spent fuel canister. The GTCC waste canister basket is fabricated in accordance with Subsection NF of Section III of the ASME Code. It is evaluated in accordance with the load combinations of Regulatory Guide 7.8, and is evaluated against the buckling criteria of NUREG/CR-6322. A brief description of these criteria is added as Section 2.1.1.5. These criteria are similar to those applied to the spent fuel basket, except that the spent fuel basket is designed and fabricated in accordance with Subsection NG of Section III of the ASME Code.

Table 2.1.2-1 is revised to include the code exceptions for the GTCC canister and basket. As noted above, since the waste canister and the spent fuel canister are designed to the same criteria, the ASME Code exceptions are the same for all canisters.

See the response to RAI 2-2.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.1.2 Design Criteria

2-2 Update Table 2.1.2-1 to reflect the pertinent ASME Code Exceptions as noted in Table 4-1 of the NAC-UMS Storage SAR for the TSC.

Section 71.7(a) requires complete and accurate information. Drawing Nos. 790-585 and -612 specify a progressive liquid penetrant nondestructive examination, or an ultrasonic examination, of the TSC and GTCC waste canister structural lid-to-shell welds. However, the Drawings are inconsistent with Table 2.1.2-l, which specifies a root and final liquid penetrant examination.

NAC Response

Table 2.1.2-1 is revised to incorporate the ASME Code exceptions previously specified in the NAC-UMS® Storage Safety Analysis Report for the transportable storage canister (TSC) and the spent fuel basket. In addition, the exceptions to the ASME Code for the GTCC waste canister basket are added to the table.

Among other clarifications, the exception to the examination of the structural lid to canister shell weld is revised to include the option of performing an ultrasonic inspection of the weld.

See the response to RAI 2-1.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.1.2.3 Load Combinations

2-3 Define for the cask cavity the maximum normal operating pressure (MNOP) considered in the following SAR text:

1. Pgs. 2.6-4 & 2.6-14, "[T]he loading conditions are: (1) 50 psig internal pressure..."
2. Table 2.6.1.1-2, "[N]ormal Design Pressure--Cask...25 psig..."
3. Pg. 2.10.2-6, "[A] pressure of 150 psig is used to conservatively envelope the normal design pressure of 25 psig for all impact loadings..."
4. Pg. 8.1-4, "[T]he transport cask containment is hydrostatically tested to 85 psig...The containment maximum normal operating pressure (MNOP) is calculated to be 8.5 psig."

Per Section 71.33(b)(5), the MNOP shall be identified.

NAC Response

The pressure used to evaluate the UMS® Transport Cask for normal and accident conditions is 150 psig. Various sections of the Safety Analysis Report are revised to clarify the analyzed cask pressure. Tables 2.6.1.1-2 and 2.6.1.1-3 are revised to show an "analyzed" pressure of the Transportable Storage Canister and Transport Cask to be 25 psig and 150 psig, respectively. The Maximum Normal Operating Pressure (MNOP) is specified in Sections 2.6.1.1, 2.6.2.1, 8.1.2.3 and 8.1.2.3 to be 7.3 psig, where the MNOP is as defined by NUREG-1617, Table 4-1.

See the response to RAIs 2-20, 2-39 and 2-49.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.1.2.3 Load Combinations

2-4 Clarify, on Pg. 2.1-9, how for the lead-pour fabrication, -40°F cold test and –20°F ambient thermal stresses are considered in the load combination structural evaluations of the cask inner shell.

Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package performance under the conditions and tests of Sections 71.71 and 71.73.

<u>NAC Response</u>

Section 2.1.2.3 is revised to incorporate a summary of the evaluation of stress associated with the lead pour that occurs in fabrication. As described in Sections 2.6.11 and 8.3.3, the lead pour procedure is specifically controlled to minimize any induced differential thermal expansion stresses in the cask body. The cask shells are instrumented with thermocouples to ensure control of the rates of the heat-up and cooldown and of the shell temperatures prior to lead pour, thus minimizing temperature differentials in the shells. The evaluation of stress resulting from the lead pour is presented in Section 2.6.11. The maximum stress in the inner shell during lead solidification is insignificant (only 255 psi). Since the residual stress in the inner shell, which is induced by the shrinkage of the lead after the pouring operation, is relieved because of the low creep strength of the lead, this stress is not considered with other loads. There are no other unrelieved stresses that occur in fabrication.

The evaluation of the -40°F cold condition is provided in Section 2.6.2 (Cold). The load combination considered for this case is (1) internal pressure with bolt preload, (2) -40°F ambient with no solar insolation and no decay heat, and (3) gravity.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-4 (Continued)

The -20°F ambient thermal condition is bounded by the "Thermal Cold" condition (-40°F ambient temperature, no solar insolation and maximum decay heat), as described in Section 2.10.2. The "Thermal Cold" condition is combined with internal pressure, bolt preload and inertia/impact loads in the evaluation of cask impacts (Sections 2.6.7 and 2.7.1).

Section 2.10.2 is also revised to clarify the load combinations considered in the analysis. Table 2.1.2-2 is revised to correct several typographical errors and to specify the load combinations that must be evaluated for normal and accident conditions.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.1.2.3 Load Combinations

2-5 Clarify, on Pg. 2.1-11, the statement, "[t]he visco-elastic behavior of the lead is considered. . .in the analysis of cask shell components."

The Section 2.7.1.5 discussion on lead slump does not appear to refer to the assumption of visco-elastic material behavior of the lead for the cask shell stress analysis. Complete and accurate information should be provided, per Section 71.7(a).

<u>NAC Response</u>

The subject sentence in Section 2.1.2.4 is revised to delete reference to "visco-elastic behavior," and to refer instead to the low yield strength (an elastic property) and the weight of the lead. Consideration of a viscous property of the lead would imply the use of a damping factor in the effect of the lead on the inner shell. No such damping factor is applied in the analysis.

The analysis considers the low yield strength of the lead in that it is assumed that the lead does not contribute to the structural strength of the cask. The effect of the weight of the lead is considered in the analysis of the cask shell components.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.1.2.3 Load Combinations

2-6 Clarify in Table 2.1.2-1, the code exception to ASME Article NB-6000, Testing, "[T]ransportable storage canister cannot have a hydrostatic or pneumatic test performed..."

The statement on pg. 8.1-7, "[T]he canister is conservatively pressure tested... 1.2 times the 15 psig design pressure..." appears to be in disagreement with the exception taken in SAR Table 2.1.2-1. Complete and accurate information should be provided in the SAR, per Section 71.7(a), for evaluating packaging codes and standards compliance, per Section 71.31(c).

<u>NAC Response</u>

The ASME Code provides that the pressure vessel is pressure tested to confirm its integrity immediately following fabrication and prior to first use. The design of the Transportable Storage Canister is such that closure of the canister (pressure vessel) does not occur until the canister is loaded with the spent fuel or radioactive waste that it confines. Consequently, pressure testing occurs immediately following loading, and as an integral step to closure and initiation of first use.

The intent of the referenced language was to differentiate the order in which use and testing occurs. Table 2.1.2-1 is revised to clarify this exception.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.1.2.5.2 Fatigue

2-7 Revise this Section and Sections 2.6.7.6 and 2.7.1.7.2, as appropriate to also consider bolt pre-loads on the cask lid closure bolts for meeting the fatigue evaluation exemption criteria of ASME NB-3222.4(d) and 3232.3(b), including provisions for fatigue strength reduction factors of NB-3232.3(c) for threaded members.

The closure bolt fatigue life needs to be evaluated, and a lower fatigue strength should be considered for the bolt. The effect of repeated use of the closure bolts under normal conditions of transport, per Section 71.71(a), should be included in the evaluation.

NAC Response

The closure bolt fatigue analysis presented in Section 2.7.1.7.2 is deleted because fatigue analysis is not applicable to accident condition loads (single occurrence). A revised bolt fatigue analysis is presented in new Section 2.6.7.6.1. The fatigue life of the closure bolts is evaluated using ASME Code Section III, Appendix I. The evaluation shows that the Transport Cask lid closure bolts have a life expectancy of 944 cycles (installation and removal). Assuming 24 cycles per year, the bolts need to be replaced after approximately 39 years.

As shown in Table 8.2-1, the lid bolts are conservatively replaced every 20 years.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.2 Weights and Centers of Gravity

2-8 Add a table of calculated weights and centers of gravity of the Universal Transport Cask for transporting the GTCC waste.

Similar to those for the five classes of design basis fuel, complete and accurate weight and center of gravity information on the GTCC waste basket should also be provided, per Section 71.7(a). They are essential for evaluating the applicability of the bounding decelerations determined for the packaging under the free drop tests of Section 71.71(c)(7) and Section 71.73(c)(1).

NAC Response

Table 2.2-3 is added to Section 2.2 to provide the calculated weights and centers of gravity for the Universal Transport Cask transporting GTCC waste.

See the response to RAI 2-57.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.3.1 Summary of Materials

2-9 Correct the gamma shield material to be chemical copper-grade lead instead of chemical lead. Section 71.7(a) requires complete and accurate information.

NAC Response

Section 2.3.1 is revised to specify the gamma shield material as chemical copper-grade lead. This lead is provided in accordance with the 1992 edition of ASTM B29. This specification is called out on NAC-UMS® Drawing 790-502.

The properties of the chemical copper-grade lead are as specified in Table 1 of ASTM B29-92, "Standard Specification for Refined Lead."

See the response to RAIs 2-10 and 2-11.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.3.1 Summary of Materials

2-10 Revise the table on pg. 2.3-2 to specify the correct grade of lead that will be used for gamma shielding.

Section 71.7(a) requires complete and accurate information. This Section does not indicate which grade of lead will be used for gamma shielding. In Table 2.3.7-1 and on Drawing No. 790-502, it appears that a "Chemical-Copper Grade" lead will be used.

NAC Response

Section 2.3.1 is revised to specify the gamma shield material as chemical copper-grade lead. This lead is provided in accordance with the 1992 edition of ASTM B29. This specification is called out on NAC-UMS® Drawing 790-502.

The properties of the chemical copper-grade lead are as specified in Table 1 of ASTM B29-92, "Standard Specification for Refined Lead."

See the response to RAIs 2-9 and 2-11.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.3.7 Shielding Materials

2-11 In Table 2.3.7-1, correct the values of the "Tensile Yield Strength." Also, indicate the source of the data in the table.

Section 71.7(a) requires complete and accurate information. It appears that the decimal point was inadvertently misplaced.

NAC Response

Table 2.3.7-1 is revised to correct the error in the 600°F value for Yield Stress and to correct the category title to "Tensile Yield Strength." The references specified in the table are the source for the respective property values. The references are given in Section 2.12.

Chemical copper-grade lead is the same material as the previously specified chemical grade lead and, therefore, has the same physical properties. Consequently, the values obtained from the references shown in Table 2.3.7-1 are correct for chemical copper-grade lead.

See the response to RAIs 2-9 and 2-10.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.4.4 Chemical, Galvanic, or Other Reactions

2-12 Demonstrate that the placement of the Universal Transport Cask into the spent fuel pool, when the cask is wet loaded, will not impact safety during fuel loading operations. Consider the effects of chemical, galvanic, or other reactions between the cask materials, including any coatings, and the spent fuel pool water. The potential for generation of combustible gases should be addressed in this evaluation. Revise the operating procedures to include appropriate controls for detecting the presence, and preventing the ignition, of any combustible gases that may be generated during cask loading operations (See RAI 7-5).

Section 71.43(d) requires that a package be made of materials that assure there will be no significant chemical or galvanic reactions. Reaction of the Universal Transport Cask components or coatings with spent fuel pool water may produce hydrogen or other flammable gases. Since the shield lids of the TSC and GTCC waste containers are welded to their shells during fuel loading operations, there is a source of heat that could lead to their ignition if sufficient flammable gas is present.

NAC Response

Section 2.4.4 and the remainder of the Safety Analysis Report are revised throughout to delete references to the in-pool loading of the Transport Cask. There is no current operational requirement for direct loading of the Transport Cask. The Transport Cask is loaded dry with the Transportable Storage Canister, and the cask cavity is subsequently evacuated and backfilled with helium. There is no significant potential for chemical, galvanic or other reactions to occur between the stainless steel cask cavity components and the stainless steel canister during loading of the Transportable Storage Canister into the Transport Cask or during subsequent transport.

See the response to RAIs 2-13, 2-14, 2-15, 2-16, 2-17 and 3-14.

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.4.4 Chemical, Galvanic, or Other Reactions

2-13 Evaluate the potential for the generation of combustible or reactive gases in both the TSC containing Maine Yankee site specific contents and the GTCC waste canister. As part of the evaluation, identify any nonmetallic materials that will be contained in either of the canisters. If particulate material will be placed inside either canister, identify the material of the particles and determine the range of particle sizes.

Section 71.43(d) requires that a package be made of materials that assure there will be no significant chemical or galvanic reactions. Reaction of unusual materials (e.g., non-stainless steel or non-Zircaloy materials, plastics, resins, etc.) with spent fuel pool water or the radiation and moderately high temperatures of the cask environment may produce flammable or combustible gases. Since the shield lids of the TSC and GTCC waste canister are welded to their shells during loading operations, there is a source of heat that could lead to ignition if sufficient amounts of flammable or combustible gas are present.

NAC Response

As noted in the NAC Response to RAI 2-12 and others, reference to the in-pool loading of the canister using the UMS® Universal Transport Cask is deleted. Consequently, at the time of transport, the canister will have previously been loaded, closed and tested in accordance with the detailed requirements presented in the Safety Analysis Report for the UMS® Universal Storage System, Docket Number 72-1015. While the GTCC waste packaging is not controlled by the requirements of 10 CFR 72, the GTCC waste canister is closed using essentially the same procedure as is used for closing canisters containing spent fuel as described in the response to RAI DP4-1. No welds are made or repaired while the canister is inside of the Transport Cask.

The Transport Cask is loaded dry with the Transportable Storage Canister, and the cask cavity is subsequently evacuated and backfilled with helium. There is no significant potential for chemical, galvanic or other reactions to occur between the stainless steel cask cavity components

**NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION**

NAC Response to RAI 2-13 (Continued)

and the stainless steel canister during loading of the Transportable Storage Canister into the Transport Cask or during subsequent transport.

The Maine Yankee site specific contents consist of standard fuel assemblies, fuel assemblies having installed thimble plugs, control components, poison rods and hollow rods and Greater Than Class C (GTCC) waste. The thimble plugs and control components are fabricated from Type 304 stainless steel and Inconel. Thimbles have small Inconel parts, while the control component rods (which contain a neutron absorber) are Inconel. The poison rods and hollow rods are fabricated from Zircaloy-4. The GTCC waste consists of sections of the reactor core shroud, which are fabricated from Type 304 stainless steel.

None of these components exhibit adverse interaction with spent fuel pool water to generate flammable or combustible gases during pool loading or canister closing operations.

The standard spent fuel assemblies, and fuel assemblies with inserted components, are installed in fuel tubes in the basket. The interior of the fuel tube is stainless steel. No adverse reactions occur, in either wet or dry conditions, between the fuel assembly components, or installed components, and the fuel tubes. Consequently, no combustible or flammable gases are formed as a result of contact between the fuel tube surfaces and the installed fuel assemblies.

The GTCC basket is entirely Type 304 stainless steel. Consequently, no adverse reactions occur, in either the wet or dry condition, between the reactor core shroud sections and the GTCC basket components.

During cutting of the core shroud, metal chips from the cutting operation are captured in a stainless steel filter assembly. The filter assembly holds a stainless steel perforated screen having 1/8-inch holes in a 3/16-inch triangular pattern. A 40-mesh stainless steel filter material is used inside of the perforated screen. This filter assembly is entirely Type 304 stainless steel. The

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-13 (Continued)

minimum chip size is expected to be 0.007 x 0.06 x 1.5 inches, with all of the chips being Type 304 stainless steel material. The filter assembly contains no organic material. Since all of the filter materials, including the captured chips, are stainless steel, no adverse reactions that could generate combustible or flammable gases occur.

The shroud cutting operation may generate "swarf"—small-size stainless steel particulate material. Swarf is captured using a 120-mesh stainless steel filter assembly at the saw suction discharge. This material is disposed of separately and is not placed in the GTCC basket.

The Maine Yankee fuel can lid assembly includes an aluminum wiper that precludes the dispersal of gross particulate material. The wiper is a thin, narrow piece of aluminum that extends around the lid and, thus, represents a very small volume of aluminum. Because Maine Yankee fuel cans are restricted to the corner locations in the PWR basket, only 4 wipers may be present in any canister. Aluminum produces a thin oxide layer that precludes further oxidation of the surface. Although aluminum in PWR pool water has the potential to produce small amounts of combustible gas (hydrogen), the volume of the gas will be insignificant from the 4 small wipers.

See the response to RAIs 2-12, 2-14, 2-15, 2-16, 2-17 and DP4-1.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.4.4.1 Component Operating Environment

2-14 Revise this Section to include wet-loading of the Universal Transport Cask, as is indicated on pg. 3.4-44, Section 3.4.7, and pg. 7.5-1, Section 7.5.

Sections from Chapters 3 and 7 clearly indicate that the Universal Transport Cask or the transfer cask is immersed in the spent fuel pool. Section 2.4.4.1 indicates that the Universal Transport Cask is dry loaded and is not immersed in the pool. Section 1.2.2 indicates that canister loading is accomplished only by use of the transfer cask. Section 71.7(a) requires complete and accurate information.

NAC Response

Chapters 3 and 7 are revised to delete Sections 3.4.7 and 7.5, which describe the wet-loading (direct loading) provision. There is no current operational requirement for direct loading of the transport cask.

As noted in the NAC Response to RAI 2-12 and others, reference to the in-pool loading of the canister using the UMS® Universal Transport Cask is deleted. Consequently, at the time of transport, the canister will have previously been loaded, closed and tested in accordance with the detailed requirements presented in the Safety Analysis Report for the UMS® Universal Storage System, Docket Number 72-1015.

See the response to RAIs 2-12, 2-13, 2-15 and 2-16.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.4.4.2.1 Stainless/Nickel Alloy Steels

2-15 In the appropriate Sections, describe how aluminum bronze ferrules and ethylene glycol are used in the Universal Transport Cask, or remove the references to these components if they are not used.

Section 71.7(a) requires complete and accurate information. References are made to aluminum bronze ferrules and ethylene glycol without a description of how these materials are used in the Universal Transport Cask.

NAC Response

Section 2.4.4.2.1 is revised to delete reference to aluminum bronze ferrules and ethylene glycol. These items are not used in the UMS® Universal Transport Cask.

See the response to RAIs 2-12, 2-13, 2-14 and 2-16.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.4.4.2.3 Nonferrous Materials

2-16 Show that the reaction between the aluminum heat transfer disks of the TSC and the spent fuel pool water is not significant with respect to its impact on safety during fuel loading operations. Revise the operating procedures to include appropriate controls for detecting the presence, and preventing the ignition, of combustible gases during cask loading operations (See RAI 7-5). The potential for generation of combustible gases should be addressed in this evaluation. The evaluation should consider (1) the temperature of the water in the TSC will change during loading and (2) the effects of both irradiation and the contact between the aluminum heat transfer disks and the stainless steel washers, which are used to position the aluminum disks. The evaluation and conclusions should be supported by calculations, experiment, or applicable data gathered from a literature survey.

Section 71.43(d) requires that a package be made of materials that assure there will be no significant chemical or galvanic reactions. Reaction of the aluminum heat transfer disks with spent fuel pool water and/or steel components may produce hydrogen in concentrations close to the lower explosive limit of hydrogen. Since the shield lid of the TSC is welded to the shell during fuel loading operations, there is a source of heat that could lead to ignition if sufficient amounts of flammable gas are present.

NAC Response

As noted in the NAC Response to RAI 2-12 and others, reference to the in-pool loading of the canister using the UMS® Universal Transport Cask is deleted. Consequently, at the time of transport, the canister will have previously been loaded, closed and tested in accordance with the detailed requirements presented in the Safety Analysis Report for the UMS® Universal Storage System, Docket Number 72-1015. The detailed evaluation of galvanic reactions, including the potential for the production of explosive gases during canister loading, is provided in Section 3.4.1 of the UMS® Universal Storage System Safety Analysis Report. As shown in that section,

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-16 (Continued)

there is little potential for galvanic reactions or corrosion, or the formation of explosive gases, since compatible materials are used in the design of the canister and basket. However, as shown in the canister loading procedure (Section 7.5.1) used in closing the canister, monitoring of combustible gas formation is required (Step 21, Section 7.5.1). Compensatory actions are required to remove the gases if the amount of combustible gas generated during canister loading exceeds 60% of the lower flammability limit (i.e., 0.6 x 4.0 = 2.4%).

No galvanic interaction, corrosion or formation of explosive gas occurs during the dry loading of the stainless steel canister in the transport cask. Subsequent to loading the canister, the transport cask cavity is subject to a vacuum and helium backfill operation, which removes air and establishes an inert atmosphere in the transport cask. The use of similar materials (stainless steel) and the presence of the helium atmosphere essentially preclude the formation of explosive gases or materials interaction.

See the response to RAIs 2-12, 2-13, 2-14 and 2-15.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.4.4.2.10 Coatings

2-17 Demonstrate that the coating applied to the BWR support disks of the TSC will not impact safety during fuel loading operations. Revise the operating procedures to include appropriate controls for detecting the presence, and preventing the ignition, of combustible gases during cask loading operations (See RAI 7-5). The potential for generation of combustible gases should be addressed in this evaluation. Also, demonstrate that the coating is not reactive and is adherent when it is exposed to PWR and BWR spent fuel pool water, radiation, and temperatures that are expected during fuel loading operations. Describe the process that was used to select the coating. Include a brief discussion of the tests and/or analyses that were conducted to qualify these coatings for use in the radiation and moderately high temperature environment. Indicate the expected impact of flaking or chipping paint on the structural integrity of the BWR support disks. Update all SAR Sections, as appropriate, to include these descriptions.

Section 71.43(d) requires that a package be made of materials that assure there will be no significant chemical or galvanic reactions. A potential reaction of the paint coating with spent fuel pool water and/or steel components may produce hydrogen or other flammable gases, or it may cause difficulty with loading the spent fuel into the cask. Since the shield lid of the TSC is welded to the shell during fuel loading, there is a source of heat that could lead to ignition if sufficient amounts of gas are present.

<u>NAC Response</u>

As noted in the NAC Response to RAI 2-12 and others, reference to the in-pool loading of the canister using the UMS® Universal Transport Cask is deleted. Consequently, at the time of transport, the canister will have previously been loaded, closed and tested in accordance with the detailed requirements presented in the Safety Analysis Report for the UMS® Universal Storage System, Docket Number 72-1015.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-17 (Continued)

Drawing 790-573 is revised to specify an electroless nickel coating on the BWR basket carbon steel support disks. Reference to Hi-Heat Silicone Aluminum No. 3731 and Amercoat 878 silicone coatings for the BWR basket support disks is deleted.

The evaluation of the chemical and galvanic reactions of the electroless nickel coating on the BWR support disks is provided in Section 3.4.1.2.2 of the Safety Analysis Report for the UMS® Universal Storage System. A detailed description of the electroless nickel coating process is provided in Section 3.8.3 of that document.

In summary, the electroless nickel coating process uses a chemical reducing agent in a hot aqueous solution to deposit nickel on a catalytic surface. The deposited nickel coating is a hard alloy of uniform thickness of 25 μm (0.001 inch), containing from 4% to 12% phosphorus. Adhesion of the nickel coating to properly cleaned carbon steel is excellent with reported bond strength in the range of 40 to 60 ksi. The coating is applied in accordance with ASTM B733-SC3, Type V, Class 1. Following its application, the nickel coating combines with oxygen in the air to form a passive oxide layer that effectively eliminates free electrons on the surface that would be available to cathodically react with water to produce hydrogen gas. Consequently, the production of hydrogen gas in sufficient quantities to facilitate combustion is highly unlikely. Test data for electroless nickel coated steel have been reported to show corrosion rates from 1 to 2 μm per year in water.

As noted in the NAC Response to RAI 2-16, the Transportable Storage Canister loading procedures require the monitoring of explosive gases, and the removal of those gases, if they exceed 60% of the lower flammability limit (i.e., 0.6 x 4.0 = 2.4%).

**NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION**

NAC Response to RAI 2-17 (Continued)

The process used to select the coating for the BWR support disks considered the service environment and performance requirements for the coating, the products generally available, and industry experience with coatings used for a similar purpose. The selection process included these steps:

1. Determine the service and performance requirements for the coating.
2. Evaluate the available coatings against the service and performance requirements.
3. Identify acceptable coatings based on requirements and availability.
4. Obtain current product data sheets and Material Safety Data Sheets (MSDS) of acceptable coatings to review against coating requirements.

The service and performance requirements established for the coating of the BWR support disk design are that the coating:

- is applied to carbon steel
- must be submersible for up to a week in clean water
- is rated Service Level 1 or 2 (EPRI TR-106160)
- does not contain Zinc
- has a service temperature of at least 200°F in water and 600°F in a dry helium environment
- has no hydrogen release, or minimal hydrogen release, when submersed in clean water
- has no, or limited, special process required for proper application or curing
- has a service environment in a high radiation field

The BWR support disks will be fabricated to the proper dimensions before each disk is electroless nickel coated. The coating is applied immediately after cleaning and preparation of

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-17 (Continued)

the disk surface to protect the support disk during the completion of the fabrication process and during storage of the basket. No subsequent cutting, machining or welding of the disk is required.

No electroless nickel coating characteristics that may enhance the performance of the support disks (such as better emissivity) are considered in the structural or thermal analyses. Therefore, no adverse effect on system performance results from incidental scratching or flaking of the coating.

The procedure used in closing the canister is provided in Section 7.5.1 for reference. As shown in the procedure, the presence of combustible gases is monitored to preclude the possibility of combustion during the welding process.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.5 Lifting and Tie-Down Standards

2-18 Justify the use of ultimate shear strength for evaluating the structural performance of the lifting and tie-down devices of the package under excessive load.

For consistency, the von Mises failure criterion, which is used in the lifting trunnion and rotation pocket stress analyses, per Section 71.45, should also be considered in the evaluation for excessive load.

<u>NAC Response</u>

Sections 2.5.2.4.1 and 2.5.2.4.2 are revised to consider the von Mises failure criterion for the lifting and tiedown devices. Application of the von Mises criterion shows that failure caused by excessive load on the rotation trunnions or shear ring will not impair the ability of the package to meet the other requirements of 10 CFR 71.

Applying the von Mises failure criterion, the ultimate shear capacity of the rotation pocket weld is 5,493,040 pounds. The ultimate shear capacity of the cask body at the interfacing area with the weld is 6,882,456 pounds. Therefore, the rotation pocket weld fails in shear before the cask body.

Similarly, the ultimate shear capacity of the shear ring weld at the lifting trunnion is 7,472,150 pounds. The ultimate shear capacity of the cask top forging at the interfacing weld is 7,845,181 pounds. Therefore, the shear ring weld fails in shear before the cask top forging.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.5.1.1.2 Secondary Lifting Trunnions

2-19 Provide a bolt pre-load analysis to be consistent with the bolt stress distribution assumption depicted in Figure 2.5.1.1-2.

Complete and relevant information on bolt pre-load should be provided to substantiate the stress distribution assumption for the trunnion attachment bolts. The validity of the structural integrity evaluation of the bolted secondary trunnions, as a lifting device per Section 71.45(a), depends on an adequate amount of pre-load in the bolts.

NAC Response

Section 2.5.1.1.2 is revised to include the bolt preload in the secondary trunnion bolt analysis. The bolts that are loaded in tension (tensile load + preload) are bounding in this analysis. The maximum bolt tension load due to the applied trunnion load is added to the bolt preload to obtain the bounding load case. Positive margins of safety are demonstrated for the bounding bolt analysis, i.e., +0.51 for yield strength and +0.39 for ultimate strength. The bolt preload is the only bolt load in the compression region.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.1 Heat

2-20 Revise the pressures listed in this Section to be consistent with the thermal Section.

The pressures stated on pgs. 2.6-1 and 2.6-2 are inconsistent with Table 3.4-4. Section 71.7(a) requires complete and accurate information.

NAC Response

Section 2.6.1 is revised to incorporate the UMS® Universal Transport Cask cavity pressures shown in Table 3.4-4 for PWR fuel and BWR fuel, respectively. The analyzed internal pressure of the cask is revised to 150 psig to reflect the pressure used in the cask model described in Section 2.10.2. Reference to "design pressure" is deleted.

See the response to RAIs 2-3, 2-39 and 2-49.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.1.3 Stress Calculations and Comparison to Allowable Stresses

2-21 Clarify, as appropriate, the underlined term below:

Pgs 2.6-4 and 2.6-14 of the SAR, "[T]he stresses throughout the cask body are calculated for...loading conditions for directly loaded fuel."

Complete and accurate information should be provided, per Section 71.7(a).

NAC Response

Sections 2.6.1.3 and 2.6.2.3 are revised to delete the reference to "... directly loaded fuel." "Directly loaded fuel" refers to loading spent fuel into the canister while the canister is in the UMS® Transport Cask and the cask is submerged in the spent fuel pool. As described in the Response to RAI 2-12 and others, the provisions for direct loading of fuel are deleted.

The individual and combined loading conditions specified in these sections are not a function of the contents in the Universal Transport Cask.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.2 Cold

2-22 Clarify, as appropriate, the meaning of the underlined term below:

Pg. 2.6-15 of the SAR, "[T]hermal hot refers to 100°F solar insolation..."

Complete and accurate information should be provided, per Section 71.7(a).

NAC Response

Section 2.6.2.3 is revised to refer to a -40°F ambient temperature condition. As specified in Section 2.6.2, the evaluated thermal condition considers a -40°F ambient temperature, no solar insolation and no decay heat load, in still air.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.2 Cold

2-23 Re-evaluate stresses in the cask body, as appropriate, by considering the minimum internal pressure in combination with the minimum decay heat load and the minimum ambient temperature.

The SAR text and Table 2.6.2.1-1 suggest that the pressure and thermal loading conditions considered deviate from those typically associated with the cold condition test of the normal conditions of transport, per Section 71.71(b).

NAC Response

The cold case load combination considered in Section 2.6.2 assumes a -40°F ambient temperature, no solar insolation, no decay heat and an internal pressure of 150 psig. This case is different from the cold case combination loading noted in Table 2.1.2-2 in that the cask minimum pressure is not used and a lower temperature (-40°F) is applied. These parameters are conservative with respect to the requirements of 71.71(b) (shown in Table 2.1.2-2), since the higher internal pressure and lower temperature result in the highest stresses for the cold case in normal conditions of transport.

Note that Section 2.6.2 is revised to consider an internal pressure of 150 psig. This pressure is used in accordance with the response to RAI 2-3.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.5 Vibration

2-24 Submit an evaluation of the fatigue strength of the tie-down system of the package.

The vibration-induced alternating stresses in the tie-down system should be evaluated under the vibration condition of the normal conditions of transport, per Section 71.71(c)(5).

NAC Response

The vibration analysis for the tie-down system is provided in Section 2.6.5. The two cask components of the tie-down system are the shear ring, at the front of the cask, and the rotation pockets at the rear. The shear ring is designed to react the assumed 10g longitudinal load. It is not loaded in the vertical direction, which is the primary vibration direction incident to transport.

The allowable alternating stress intensity, or fatigue strength, is based on the 10^{11} cycle value from Table 1-9.2.2 of Section III of the ASME Code, and is 23,700 psi. The calculated alternating shear stress due to vibration is ± 5,597 psi. The resulting Margin of Safety is + 3.2. Therefore, the transport cask rotation pockets satisfy the requirements for normal vibration incident to transport in accordance with 10 CFR 71.71(c)(5).

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.7 Free Drop (1 Foot): Cask Body Analysis

2-25 Clarify the text by defining explicitly the free-drop deceleration g-loads used in the bounding analyses of the cask body.

Complete and accurate information should be provided, per Section 71.7(a).

NAC Response

Section 2.6.7 is revised to show that a 20g deceleration load is used in the normal conditions of transport end and side drop analyses as a bounding g-load. Reference is made to Table 2.6.7.5-3 for the calculated g-load for the end and side drop conditions.

Sections 2.6.7.1 and 2.6.7.2 are similarly revised to show that 20g is used as the bounding g-load for the one-foot end drop and one-foot side drop evaluations, respectively.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.7 Free Drop (1 Foot): Cask Body Analysis

2-26 In Table 2.6.7.2-1, revise, as appropriate, the stress allowable of 20.0 ksi to be consistent with that of 19.1 ksi of Table 2.6.1.3-1 for shell section 13, and re-evaluate stress margins accordingly.

Shell section 13 is shown to have the lowest stress margin for the cask. The stress allowable in Tables 2.6.7.2-1 and 2.6.1.3-1 are expected to be identical for the shell section under the same ambient temperature of 100°F. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package performance under the Section 71.71 normal conditions of transport.

NAC Response

The allowable stress shown in Table 2.6.7.2-1 for Sections 10 through 13 is revised to 19.1 ksi to be consistent with Table 2.6.1.3-1. The Margins of Safety for these sections are revised accordingly.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.7 Free Drop (1 Foot): Cask Body Analysis

2-27 With respect to Table 2.6.7.1-2, justify the use of a higher stress allowable of 29.6 ksi for shell Section 22 than that of 19.7 ksi for Section 21 for the same shell material.

Table 2.10.2.2-1 lists an identical temperature of 322.6°F for the two shell sections for stress evaluation. Generally, the same stress allowable should be applicable to the two shell sections in close proximity. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package performance under the Section 71.71 normal conditions of transport.

<u>NAC Response</u>

The allowable stress value of 29.6 ksi used for Section 22 in Table 2.6.7.1-2 is the Primary Membrane plus Primary Bending ($P_m + P_b$) stress limit for the section; this value is correct.

The allowable stresses and margins of safety for Sections 16 through 21, and for Sections 24 through 30, shown in Table 2.6.7.1-2 are not correct. The correct allowable stress for the Primary Membrane plus Primary Bending ($P_m + P_b$) stress category is $S_{allow} = 1.5S_m$, which is 29.6 ksi for Sections 16 through 21 and is 28.7 ksi for Sections 24 through 30. Consequently, Table 2.6.7.1-2 is revised to incorporate the $P_m + P_b$ stress allowables for these sections, with the corresponding revisions to the associated margins of safety.

Sections 2.6.7.1 through 2.6.7.3 are also revised throughout as a result of these revisions in the allowable stresses.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.7.5 Impact Limiters

2-28 Justify the use of a factor of 0.9, on pg. 2.6-64, for the redwood crush stress-strain curve to account for the suggested negative fabrication tolerance for the impact limiters.

A negative fabrication tolerance, as suggested, may not exist. The use of the factor of 0.9 should only be considered for calculating a bounding cask deceleration by the RBCUBED program. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package free-drop performance under Sections 71.71(c)(7) and 71.73(c)(1).

NAC Response

The 0.9 and the 1.1 factors were employed with the previous methodology of designing the impact limiter using RBCUBED. The present methodology uses dynamic force deflection data for the redwood and the balsa wood, in conjunction with the LS-DYNA finite element program. The improved methodology has been shown to bound the actual quarter-scale model drop test data. The specifications for the redwood used for the construction of the quarter-scale model impact limiters are identical to those for the full-scale impact limiter design. Therefore, the quarter-scale model drop tests not only validate the analytical methodology, but also the methods and materials employed in the fabrication of the impact limiters.

There are four levels of conservatism in the impact limiter design.

1) The design acceleration values used for the structural evaluations are greater than the acceleration values calculated using the LS-DYNA program.
2) The LS-DYNA calculated acceleration values are greater than the quarter-scale model drop test accelerations. The quarter-scale model drop tests were conducted at ambient temperature and the LS-DYNA prediction of the quarter-scale model accelerations used ambient temperature wood properties.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-28 (Continued)

3) The full-scale impact limiter design analyses use the 200°F properties for the wood (the maximum normal operation temperature of the impact limiter is 135°F). Similarly, for the cold condition, the full-scale impact limiter design evaluations were performed using wood properties at -40°F (the minimum normal operation temperature is -20°F). This ensures that bounding maximum accelerations and crush depths are calculated.
4) Based on the side drop test performed at Sandia National Laboratory, there exists an additional 25% margin for energy absorption based on the discussion presented in Section 2.10.3.4.5. The side drop is the critical drop orientation for energy absorption.

Considering these areas of conservatism, the implementation of additional factors of 0.9 and 1.1 is not necessary to assure the design adequacy of the impact limiters.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.7.5 Impact Limiters

2-29 Justify the use of a factor of 0.9, on pg. 2.6-65, for the balsa wood crush stress-strain curve, at 152°F, to account for the suggested fabrication tolerance for the impact limiters.

Reference 37 of the SAR, "NAC-STC Safety Analysis Report," considered the same factor of 0.9, but for a higher temperature of 230°F. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package free-drop performance under Sections 71.71(c)(7) and 71.73(c)(1).

<u>NAC Response</u>

Please refer to the NAC Response to RAI 2-28. RAI 2-28 addresses the resolution of the 0.9 factor for the wood materials used in the impact limiters.

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.7.5 Impact Limiters

2-30 Clarify, as appropriate, the underlined typographical or editorial errors:

1. Pg. 2.6-72, "[T]able 2.6.7.5-4 shows that at impact angles of 60° and 75°, ...the secondary impact..."

A comparison of the E_{max} and El values in the table suggests that the SAR statement does not appear to be applicable to the case with an impact angle of 60°. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package free-drop performance under Section 71.73(c)(1).

2. Table 2.6.7.5-4, "[E]nergy...absorbed in second limiter...8.2%..."

The percentage value listed does not appear to be consistent with the other data summarized in the table. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package free-drop performance under Section 71.73(c)(1).

NAC Response

Section 2.6.7.5 is revised throughout to incorporate an impact limiter analysis performed using the LS-DYNA computer code. This revised analysis deletes the subject tables.

See the response to RAI 2-31.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.7.5 Impact Limiters

2-31 Justify, with test or analytical results, that the free drop at a 75° oblique drop angle would give rise to the bounding deceleration of the trailing impact limiter in a slap-down event.

The SAR should provide the basis for the assumption that a 75° oblique drop would produce the largest deceleration, thus, the most limiting and damaging condition, to the package undergoing a secondary impact. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package free-drop performance under Section 71.73(c)(1).

NAC Response

Section 2.6.7.5 is revised throughout to incorporate an impact limiter analysis performed using the LS-DYNA computer code. LS-DYNA has been used to model the NAC-STC transport cask (NRC Docket 71-9235) for shallow, oblique drops. The NAC-STC transport cask analysis shows that the bounding accelerations occur in the side drop. The UMS® transport cask is similar to the NAC-STC transport cask in terms of L/r (length to radius of gyration). Section 2.6.7.5.8 is added to compare NAC-STC and UMS® transport cask LS-DYNA results.

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.7.5 Impact Limiters

2-32 Considering the at-temperature impact limiter force-deflection curves in lieu of those associated with Figures 2.6.7.5-11 through 2.6.7.5-17 for bounding temperatures, demonstrate that the impact limiter drop test results can adequately be predicted with those calculated by program RBCUBED.

The impact limiter force-deflection curves displayed in the figures apply to the bounding temperatures. The force-deflection curves for the temperature at which the tests were conducted should be considered for evaluating correlation between the test and calculated results. Complete and accurate information should be provided in the SAR, per Section 71.7(a), for evaluating the package free-drop performance under Sections 71.71(c)(7) and 71.73(c)(1).

NAC Response

Section 2.6.7.5 is revised throughout to incorporate an impact limiter analysis performed using the LS-DYNA computer code. The subject figures, and reference to RBCUBED, are deleted in the revised analysis. In Section 2.6.7.5.8, the revised analysis is performed for the NAC-STC quarter-scale model top end, top and CG over corner, side and slap-down (75°) drops at ambient temperature to benchmark the LS-DYNA code for cask drop and impact limiter analyses.

NAC International calculations EA-790-2234 and EA-790-2235, were previously submitted to the NRC on March 14, 2001, as proprietary information.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.7.5 Impact Limiters

2-33 For the 1-foot free drop results summarized in Table 2.6.7.5-1, explain why the calculated deceleration force for the lower impact limiter is larger than that for the upper impact limiter.

For the same impact limiter deformation of 1 inch, the upper impact limiter with a larger backed area than the lower impact limiter should give rise to a higher deceleration force in an end-drop event. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package free-drop performance under Section 71.71(c)(7).

<u>NAC Response</u>

Section 2.6.7.5 is revised throughout to incorporate an impact limiter analysis performed using the LS-DYNA computer code. The revised analysis presentation deletes the subject table. The revised analysis shows that the 1-foot top end drop acceleration is larger than the 1-foot bottom end drop acceleration (see Table 2.6.7.5-6).

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.7.5 Impact Limiters

2-34 For the corner impact force-deformation curves shown in Figures 2.5.7.5-12 and 2.5.7.5-15 for the lower and upper impact limiters, respectively, explain why the curves are markedly different in shape for initial deformations of about 4 inches or less.

For the identical redwood and balsa wood material properties, the RBCUBED calculated force-deformation curves are expected to have a similar shape for the essentially identical design for the upper and lower impact limiters. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package free-drop performance under Sections 71.71(c)(7) and 71.73(c)(1).

NAC Response

The RBCUBED analyses and associated figures have been replaced with LS-DYNA analyses and the associated figures and tables. For the LS-DYNA analyses, only the top corner drop was considered. The top corner represents a bounding case because of the addition of the trunnion pocket and more available crush area. Hot (200°F) and cold (-40°F) material properties are used to bound the range and variations in wood properties. The following table summarizes the revised top corner drop analysis results.

Drop Description	Peak Acceleration	Maximum Crush
30-ft Top Corner Drop Cold	36.5	18.6
30-ft Top Corner Drop Hot	35.3	20.2

Refer to the revised Section 2.6.7.5.5 for a complete description of the analyses.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.6.12.12 Canister Buckling Evaluation for 1-Foot End Drop

2-35 Describe how the ANSYS dynamic shell analysis was performed for the maximum stresses used in the buckling evaluation of the TSC.

Complete and accurate information should be submitted for review, per Section 71.7(a).

NAC Response

The stresses used in the buckling evaluation are based on the static analysis for the canister as presented in Section 2.6.12.4 through 2.6.12.9. Section 2.6.12.12 is revised to delete the reference to "dynamic shell analysis," which is an incorrect description of the canister analysis.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Sections 2.6.13 & 2.6.15 PWR and BWR Basket Analysis—Normal Conditions of Transport

2-36 With respect to Tables 2.6.12.8-1 and 2.6.14.8-1, for the PWR and BWR canisters, respectively, explain why the minimum stress margins and critical cross sections are shown markedly different from each other (0.02 at Section 2 vs. 0.52 at Section 9) for the top corner-drop.

The PWR and BWR canisters are essentially identical in design configurations and loading conditions except that the BWR canister is slightly longer. As such, because of the same stress analysis approach, minimum stress margins of similar order of magnitude are expected for the same canister cross section locations. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package performance under the Section 71.71 normal conditions of transport.

NAC Response

The minimum stress margins and critical cross sections are different because of the geometry of the basket bottom weldment. The PWR bottom weldment is 2 inches high, while the BWR bottom weldment is 5 inches high. For the top corner drops, these weldment plates have a lateral component of loading that causes them to bear against the side of the canister shell, right above the location of Section 2 (see Figures 2.6.12.3-1 and 2.6.14.3-1). Since the distance between the bottom weldment plate and the canister bottom plate (Section 2) is shorter for the PWR design, there is a more localized edge contact for the PWR canister and, consequently, a higher local stress. As shown in Tables 2.6.12.8-1 and 2.6.14.8-1, the radial stress component (SX) at Section 2 is -19.4 ksi and -8.9 ksi for the PWR and BWR canisters, respectively. Therefore, the minimum stress margin for the PWR canister (0.02 at Section 2) is markedly lower than that for the BWR canister (0.52 at Section 9).

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Sections 2.6.13 & 2.6.15 PWR and BWR Basket Analysis—Normal Conditions of Transport

2-37 Submit the support disk modal properties data to demonstrate that dynamic load factors (DLFs) have appropriately been considered in analyzing support disk ligaments.

The cask deceleration may need to be amplified by dynamic effects for defining the deceleration forces for quasi-static analyses of basket support disks. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package performance under the Section 71.71 normal conditions of transport.

NAC Response

The Safety Analysis Report is revised to incorporate Section 2.10.4, which presents an evaluation of the dynamic load factor (DLF) for the PWR and BWR support disks. The 1-foot end drop and 1-foot side drop conditions are selected for the evaluation.

The maximum accelerations and DLFs for the 1-foot end drop and 1-foot side drop orientations for the PWR and BWR support disks are:

Fuel Type	Drop Orientation	Maximum Acceleration (g)		DLF
		Input	Response	
PWR	End	17.1	13.45	0.79
PWR	Side	16.4	14.99	0.91
BWR	End	17.1	13.53	0.79
BWR	Side	16.4	15.72	0.96

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-37 (Continued)

For all cases, the DLF is less than 1.0 and the maximum response is below the design basis g-load (20g) used in the support disk evaluation for normal conditions of transport. Similar results are expected for the accident conditions and, therefore, no further evaluation is performed.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Sections 2.6.13 & 2.6.15 PWR and BWR Basket Analysis—Normal Conditions of Transport

2-38 Revise Tables 2.6.15.4-1, -2 and 2.6.15.5-1 of the SAR by also listing stress allowables and corresponding design margins for the support disk.

Complete and accurate information should be presented in the SAR, per Section 71.7(a).

<u>NAC Response</u>

Tables 2.6.15.4-1, 2.6.15.4-2 and 2.6.15.5-1 are revised to include the allowable stress and margin of safety for the reported support disk nodes.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.7.1 Free Drop (30-ft)—Cask Body Analysis

2-39 Identify the maximum design internal pressure used in determining cask bounding stresses.

Table 2.7.3.1-4 lists a maximum cask cavity pressure of 75 psig. Pg. 2.10.2-6 cites a pressure of 150 psig. On the basis of the Section 2.7.1 description, however, it is not clear whether a cask internal pressure of 75 psig is considered in the load combination evaluation for the 30-ft cask drops. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package performance under the Section 71.73 hypothetical accident conditions.

NAC Response

Two cask cavity pressure values are applied in the analysis of the UMS® Universal Transport Cask. A cavity pressure of 150 psig is used in the finite element model analyses of the cask body (model description, Section 2.10.2). A cavity pressure of 80 psig is used in the evaluation of the cask closure lid bolts (Section 2.6.7.6). Both of these pressures bound the calculated maximum cask cavity pressure, 59.86 psig (Section 3.5.4.1.2).

These pressures (150 psig and 80 psig) were selected and applied to allow cask structural analysis to proceed before the maximum pressure, based on cask contents and maximum temperature, was calculated.

The cask design internal pressure (75 psig) was initially selected to be greater than any calculated cask internal pressure, but less than the bounding pressure used in the analysis (150 psig). It is specified for the purpose of establishing a limit for any

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-39 (Continued)

subsequent evaluation of a package condition. It is not used in any ANSYS or classical analysis of the package. As described in the Response to RAI 2-20, reference to "design pressure" is deleted.

Section 2.7.1 is revised to show that an internal pressure of 150 psig is used in the finite element analysis of the transport cask in the 30-foot drop events. Table 2.7.3.1-4 is revised to reference the bounding pressures of 150 psig used in the ANSYS finite element analysis and 80 psig used in cask closure lid bolt analysis.

See the response to RAIs 2-3, 2-20 and 2-49.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.7.1.5 Lead Slump Resulting From a Cask Drop Accident

2-40 Submit an analysis of lead slump resulting from cask drop accidents.

Supporting analyses are necessary to complete the review; the SAR provides only a summary description of lead slump evaluation results. Complete and accurate information should be provided, per Section 71.7(a).

NAC Response

Section 2.7.1.5 is revised to incorporate the lead slump analysis for the end and side impact accident events. As shown in Section 2.7.1.5, the lead slump in the end impact event is 3.05 inches. The lead slump is 0.91 inches in the side impact event. No significant increase in dose rate results from the reduction in shielding represented by the slump condition.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.7.1.7 Closure Analysis

2-41 Submit an analysis of deformations and stresses for the protection lip of the cask top forging for the 30-foot free drop conditions.

The SAR uses the NUREG/CR-6007 approach for the closure analysis, which provides that the closure bolts should be protected from direct impact to minimize bolt forces generated by free drops. The deformations of the protection lip should be shown to be less than the design diametric gap of 0.16 inch (78.36" - 78.20" = 0.16") between the closure lid and the protection lip under the free drop hypothetical accident conditions of 10 CFR 71.73(c)(1).

NAC Response

Section 2.7.1.7.1 is revised to include an evaluation of deformation and stresses for the protection lip of the cask top forging.

To ensure that the closure lid bolts are not subjected to any force resulting from the contact of the cask lid and protecting lip of the cask top forging (flange), deflections of the lid edge and the flange during the 30-foot drop impact are examined. The side and top corner drops are considered bounding for the lid/flange interaction. The deflection and stress results for the lid edge and cask flange are obtained from the cask finite element analyses corresponding to these drop conditions (Sections 2.7.1.2 and 2.7.1.3).

The nominal radial gap that exists between the cask lid and flange is (78.36 – 78.20)/2 = 0.08 inch. To determine the amount of change in the nominal gap, the radial deflections at each node on the top outer radius of the lid and the adjacent flange node are obtained from the analyses for both the side and top-corner impacts. The change of radial gap due to the drop events is calculated as:

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-41 (Continued)

Radial gap change = $UX_{flange} - UX_{lid}$

Where:

UX_{flange} is radial deflection of the flange node.
UX_{lid} is the radial deflection of the lid.

Radial gap change is the amount of gap closure (or opening). It is positive when the gap is opening and negative when the gap is closing.

Tables 2.41-1 and 2.41-2 of this response list the calculated deflections for the cask flange and lid relative to the cask centerline for the side and corner drops, respectively. The angular position noted in the table represents the circumferential location of the nodes (0° point of contact for the side drop). For the side drop, the maximum gap closure is 0.0019 inch. For the top-corner drop, the maximum gap closure is 0.0005 inch. Since these gap closures are much less than the nominal radial gap of 0.08 inch, no contact results between the lid and cask flange. Therefore, the cask lid closure bolt will not be subjected to forces due to the deformation of the cask protective lip (flange) during the 30-foot free drops.

The stresses at the cask protective lip (flange) are also reviewed for the 30-foot side and top-corner drops (Sections 2.7.1.2 and 2.7.1.3). The maximum stress at the cask flange (at Section location 36, Figure 2.10.2.2-4) is 22.4 ksi for primary membrane stresses and 24.0 ksi for the primary membrane plus bending stresses. The corresponding margins of safety are 1.14 and 1.61 for membrane and membrane plus bending, respectively.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-41 (Continued)

Table 2.41-1 Cask Lid and Flange Deflections During 30-foot Side Drop

Lid Node	Lid Radial Deflection (inch)	Flange Node	Flange Radial Deflection (inch)	Angular Position (degree)	Change in Nominal Gap (inch)
801	0.1273	633	0.1262	0	-0.0011
1872	0.1261	1704	0.1242	10	-0.0019
2943	0.1219	2775	0.1201	20	-0.0018
4014	0.1150	3846	0.1136	30	-0.0014
5085	0.1050	4917	0.1041	40	-0.0010
6156	0.0918	5988	0.0913	50	-0.0005
7227	0.0754	7059	0.0754	60	0.0000
8298	0.0548	8130	0.0571	70	0.0023
9369	0.0315	9201	0.0348	80	0.0033
10440	0.0061	10272	0.0084	90	0.0023
11511	-0.0333	11343	-0.0329	105	0.0004
12582	-0.0711	12414	-0.0713	120	-0.0002
13653	-0.1040	13485	-0.1042	135	-0.0002
14724	-0.1293	14556	-0.1297	150	-0.0004
15795	-0.1453	15627	-0.1457	165	-0.0004
16866	-0.1509	16698	-0.1511	180	-0.0002

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-41 (Continued)

Table 2.41-2 Cask Lid and Flange Deflections During 30-foot Top Corner Drop

Lid Node	Lid Radial Deflection (inch)	Flange Node	Flange Radial Deflection (inch)	Angular Position (degree)	Change in Nominal Gap (inch)
801	0.0540	633	0.0537	0	-0.0003
1872	0.0531	1704	0.0527	10	-0.0004
2943	0.0511	2775	0.0506	20	-0.0005
4014	0.0481	3846	0.0478	30	-0.0003
5085	0.0438	4917	0.0437	40	-0.0001
6156	0.0384	5988	0.0384	50	0.0000
7227	0.0311	7059	0.0324	60	0.0013
8298	0.0227	8130	0.0250	70	0.0023
9369	0.0131	9201	0.0157	80	0.0026
10440	0.0027	10272	0.0048	90	0.0021
11511	-0.0135	11343	-0.0122	105	0.0013
12582	-0.0287	12414	-0.0278	120	0.0009
13653	-0.0418	13485	-0.0412	135	0.0006
14724	-0.0520	14556	-0.0515	150	0.0005
15795	-0.0583	15627	-0.0576	165	0.0007
16866	-0.0602	16698	-0.0592	180	0.0010

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.7.3 Thermal

2-42 The maximum fuel rod cladding temperature tabulated in Table 2.7.3.1-2 is inconsistent with that found in Chapter 3. Revise for consistency. Section 71.7(a) requires complete and accurate information.

NAC Response

Table 2.7.3.1-2 is revised to correct typographical errors and to make it consistent with Table 3.5-2.

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.7.3 Thermal

2-43 Revise Table 2.7.3.1-3 to the corrected BWR canister internal pressure calculated in Section 3.5-8. Section 71.7(a) requires complete and accurate information.

NAC Response

The calculated internal pressure of the BWR transportable storage canister and UMS® Universal Transport Cask are shown on Page 3.5-8 in Section 3.5.4.2.

The transportable storage canister pressure is calculated in Section 3.5.4.2.1 and is 39.96 psig. This value is correct as shown on Page 3.5-8, and in Tables 3.5-3 and 2.7.3.1-3.

The transport cask cavity pressure is calculated in Section 3.5.4.2.2 and is 39.2 psig. This value is correct as shown in Tables 3.5-3 and 2.7.3.1-3, but is not correct as shown on Page 3.5-8. The transport cask cavity pressure calculation shown on Page 3.5-8 incorrectly repeats the calculation of the internal pressure for the canister.

Consequently, Section 3.5.4.2.2, Page 3.5-8, is revised to show the correct calculation of transport cask cavity pressure in the accident case for the BWR fuel contents. The correct cavity pressure is 39.2 psig.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.7.8.4 & 2.7.10.4 Fuel Tube Analysis

2-44 Demonstrate the structural integrity of the fuel tube under the "line" load, as exerted by the spacer grid onto the mid-span of the fuel tube, in a cask side drop event.

The uniformly distributed "area" load may not yield bounding results, and loadings based on an equally realistic assumption of line load distribution should also be evaluated. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package under the free-drop condition and test of the Section 71.73(c)(1) hypothetical accident conditions.

NAC Response

Sections 2.7.8.4 (PWR fuel tube analysis) and 2.7.10.4 (BWR fuel tube analysis) are revised to include analysis of the "line" load condition. The weld evaluation for the BORAL cover plate is also revised due to the use of the intermittent weld, rather than the continuous weld, configuration.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.7.10 BWR Basket Analysis – Accident Conditions

2-45 Revise Tables 2.7.10.1-23 and -24 by also listing stress allowables and corresponding design margins for the support disk.

Complete and accurate information should be presented in the SAR, per Section 71.7(a).

NAC Response

Tables 2.7.10.1-23 and 2.7.10.1-24 are revised to include the allowable stress and Margins of Safety for the reported support disk nodes.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.7.10 BWR Basket Analysis – Accident Conditions

2-46 Clarify, as appropriate, the underlined typographical or editorial errors. Complete and accurate information should be presented, per Section 71.7(a).

Table 2.7.10.1-24, "$P_m + P_b$ Stresses for Support Disk...Thermal Case 2"

Table 2.7.10.1-22, refers to thermal Case 4, in lieu of Case 2, for stress evaluation.

NAC Response

The title of Table 2.7.10.1-24 is revised to refer to Thermal Case 4.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.10.1 Computer Program Description

2-47 Describe the revisions made to the RBCUBED program, subsequent to its previous application in July 1992, for the NAC Storable Transport Cask (NAC-STC).

The SAR refers to the November 1996 version of the program. However, it is not clear whether the 1992 version of the program has been modified and appropriately validated for the present Universal Transport Cask application. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the program for meeting the Section 71.101(a) quality assurance requirements.

NAC Response

The RBCUBED program is no longer used for any UMS® transport cask evaluations, so all references to the program have been deleted from the SAR.

As described in the response to RAI 2-51 and others, the LS-DYNA program is now used to evaluate the impact limiters and determine the impact loading on the UMS® transport cask. The LS-DYNA description is provided in Section 2.10.1.2.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.10.2 Finite Element Model—Universal Transport Cask

2-48 Justify the use of CONTAC52 elements between the stacked annulus plates (Item 33, Drawing No. 790-502) connecting the inner and the outer shells of the cask.

The finite element analysis model should not allow force interaction between the annulus plates because a gap between the plates could potentially result from cask fabrication. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the adequacy of the cask finite element model.

NAC Response

The use of CONTAC52 elements is acceptable so long as an appropriate gap size is defined for the elements. To demonstrate that there is no interaction between the annulus plates, the 1-foot (Section 2.6.7.1) and 30-foot (Section 2.7.1.1) drop impacts are evaluated assuming an initial gap size of 0.01 inch. The finite element model is revised to model this assumed gap using CONTAC52 elements.

The maximum effect on annulus plate stresses due to the gap size between the annulus plates occurs in the bottom end drop. In the bottom end drop, the annulus plates are subjected to the maximum load from the lead in the cask. The analysis results show that the gap between the annulus plates remains open, i.e., there is no interaction between the stacked annulus plates.

The stress tables corresponding to the bottom end drops in Sections 2.6.7.1 and 2.7.1.1 are revised to incorporate the stress results from this modified finite element cask model analysis.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.10.2 Finite Element Model—Universal Transport Cask

2-49 Identify appropriately the cask internal pressures considered in evaluating cask structural performance under normal conditions of operation and hypothetical accident conditions.

Pg. 2.10.2-6 states, "A pressure of 150 psig is used to conservatively envelope the normal conditions design pressure of 25 psig for all impact loadings considered." Pgs. 2.6-4 and -14 cite a cask internal pressure of 50 psig for normal conditions of operation. Pg. 2.7-1 discusses the application of the maximum design internal pressure to produce bounding stresses, but provides no pressure value for analyzing hypothetical accident conditions. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package structural performance under the conditions and tests of Sections 71.71 and 71.73.

NAC Response

Sections 2.6.1.3 (Page 2.6-4), 2.6.2 and 2.6.2.3 (Page 2.6-14) are revised to delete reference to an internal pressure of 50 psig and to incorporate reference to the analyzed pressure of 150 psig. An internal pressure of 150 psig is used in the cask model described in Section 2.10.2. The 150-psig pressure is also incorporated in Section 2.7.1. Other related sections have been revised to clarify the calculated internal pressure versus the bounding internal pressure used in the analyses.

See the response to RAIs 2-3, 2-20 and 2-39.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.10.3 Confirmatory Testing Program—UMS Impact Limiters and Attachments

2-50 Provide relevant test results and analyses to demonstrate that the RBCUBED program can be used to model the free-drop performance of the UMS Universal Transport Cask.

The SAR description suggests that the confirmatory testing program needs to be clarified for the following inconsistencies in test execution and data reduction:

1. The 1/4-scale cask model should also provide proper simulation of the cask mass moment inertia, in addition to the mass and its center of gravity. The use of weight disks at only the cask top end may not be representative.

2. The measured acceleration time history in Figure 2.10.3-6 suggests significant cask rocking, which is uncharacteristic of a Universal Transport Cask undergoing side-drop response.

3. The end-drop acceleration time history in Figure 2.10.3-1 appears to contain much more spurious components than the similar time history for the 1/4-scale drop test conducted for the NAC-STC.

Complete and accurate information should be provided, per Section 71.7(a), for evaluating the testing program intended for confirming the calculated package performance under the free drops of Sections 71.71(c)(7) and 71.73(c)(1).

<u>NAC Response</u>

1. The mass moment of inertia for the full-size cask is calculated to be 3.99×10^9 lb-in^2, about the centerline of the cask base. Converting the full-size cask mass

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-50 (Continued)

moment of inertia by the scale factor $1/(4^5)$, the quarter-scale model cask should have a mass moment of inertia of 3.90×10^6 lb-in^2 about its base. The calculated mass moment of inertia of the quarter-scale model cask is 3.87×10^6 lb-in^2, a difference of 0.7%. This difference is considered to be acceptable. Section 2.10.3.1 is revised to clarify that mass moment of inertia was considered in the model design.

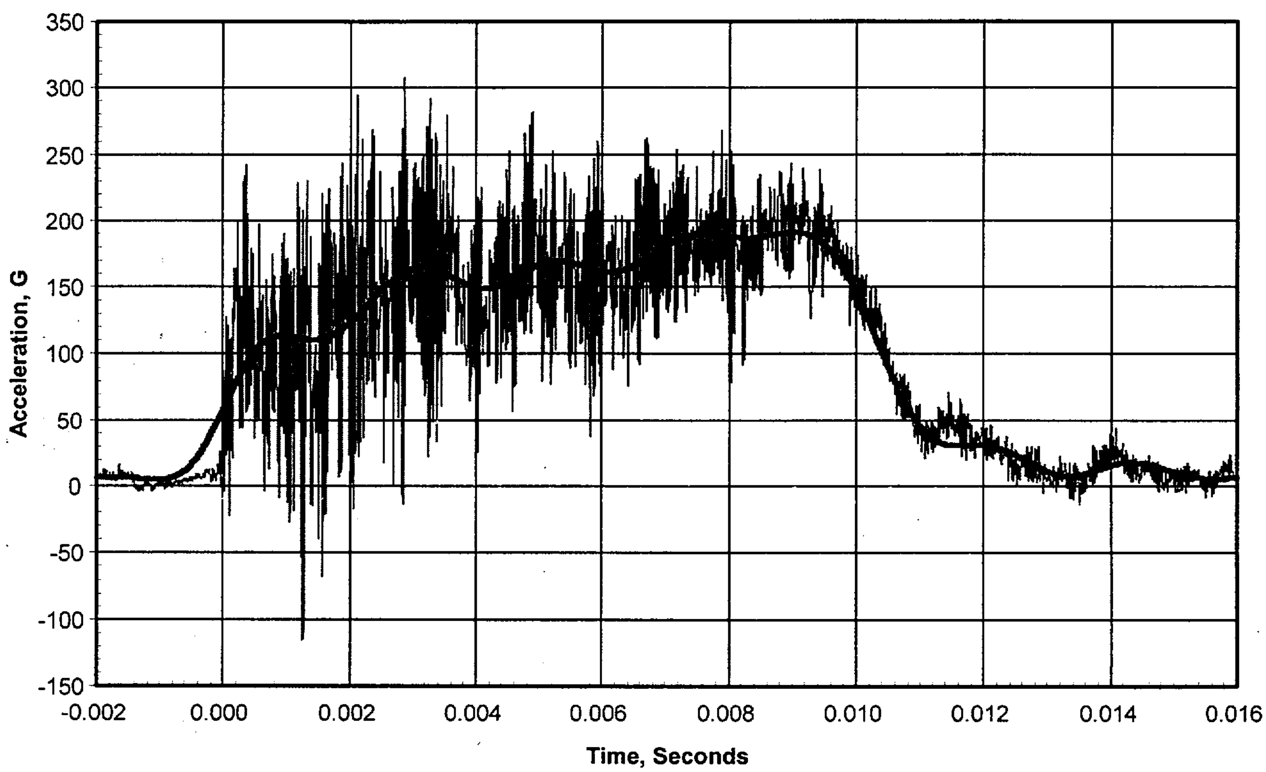
2. A side drop test performed at Sandia National Laboratory on March 13, 2001, showed none of the uncharacteristic rocking response noted during the Oak Ridge side drop test. Figures 2.50-1 through 2.50-4 of this response show the filtered and unfiltered test results and compare the LS-DYNA analysis prediction to side drop test data. These results and details of the Sandia test have been added to Section 2.10.3.7.

3. The method of filtering the acceleration for the end drop was reviewed and was correlated with the balance of energy. This is reflected in the energy absorption traces for all three accelerometers used in the end drop. These figures are presented in the response to RAI 2-51.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-50 (Continued)

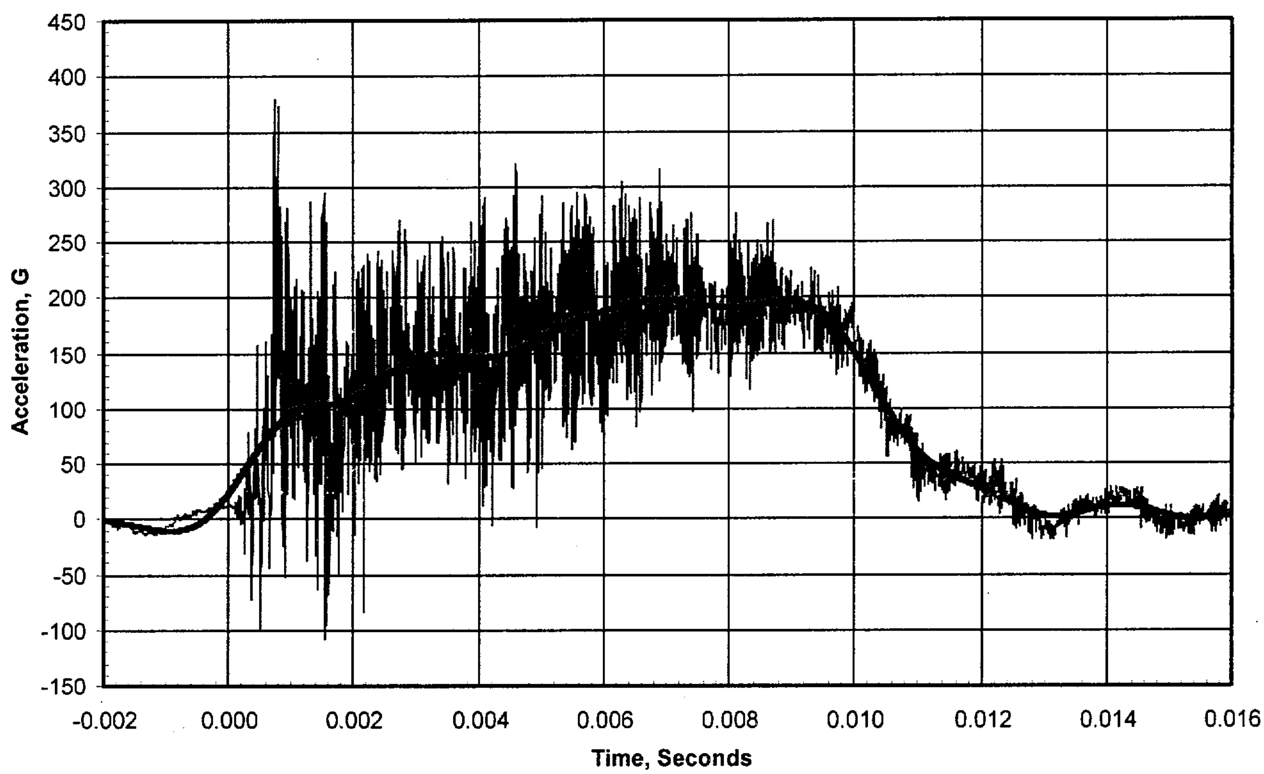
Figure 2.50-1 Typical Filtered Acceleration (Top Accelerometer) Time History for the Quarter-Scale Model Side Drop, Overlayed with the Unfiltered Data



NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

<u>NAC Response to RAI 2-50 (Continued)</u>

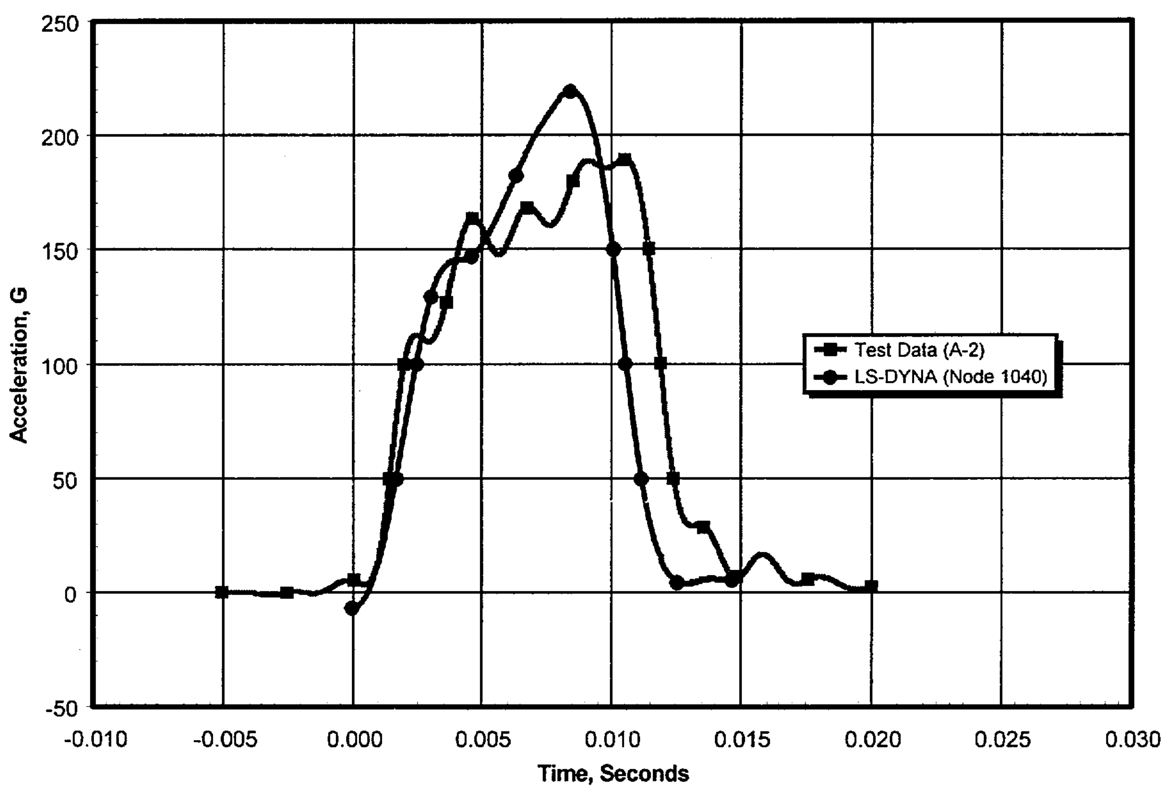
Figure 2.50-2 Typical Filtered Acceleration (Bottom Accelerometer) Time History for the Quarter-Scale Model Side Drop, Overlayed with the Unfiltered Data



NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-50 (Continued)

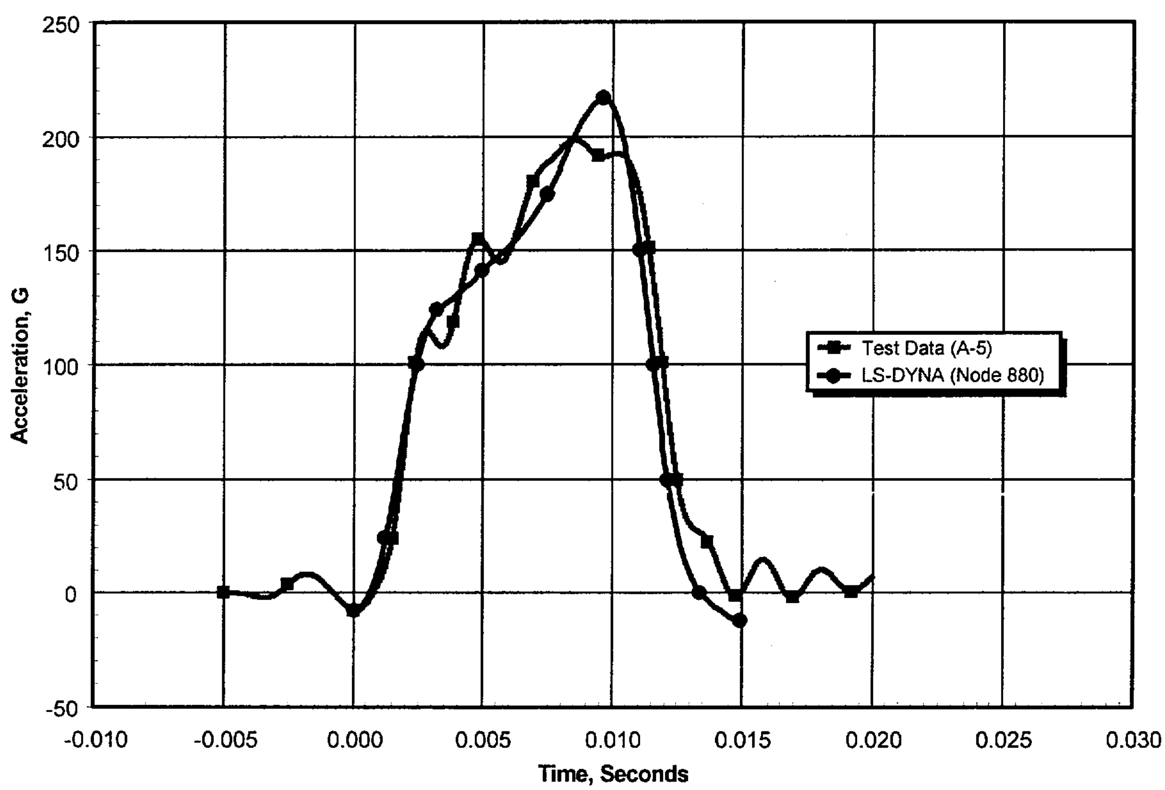
Figure 2.50-3 Comparison of Quarter-Scale Side Drop (LS-DYNA and Drop Test) Results (Upper Accelerometer)



NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-50 (Continued)

Figure 2.50-4 Comparison of Quarter-Scale Side Drop (LS-DYNA and Drop Test) Results (Lower Accelerometer)



NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.10.3 Confirmatory Testing Program—UMS Impact Limiters and Attachments

2-51 Use all measured accelerometer time history traces for data evaluation and correlation with analytical results, and submit those traces and corresponding filtered results for staff review.

Measured accelerometer time histories from all four accelerometers should be considered to ensure that test results are consistently interpreted for data correlation evaluation. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the testing program intended for confirming the calculated package performance under the free drops of Sections 71.71(c)(7) and 71.73(c)(1).

NAC Response

The scaled model drop testing for the UMS® is comprised of two testing programs. In April 1999, the 30-foot end drop and the 30-foot CG over corner drops were performed at Oak Ridge National Laboratory. In March 2001, the 30-foot side drop was performed at Sandia National Laboratory.

The filtered and unfiltered acceleration time history traces and energy data curves for the top 30-foot end drop are provided in Figures 2.51-1 through 2.51-6 of this response. Acceleration data from the three accelerometers used in the 30-foot top end drop test are presented in those figures. The filtered data is superimposed on the unfiltered data. The 30-foot top corner drop unfiltered and filtered acceleration data are provided in Figures 2.51-7 through 2.51-9.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-51 (Continued)

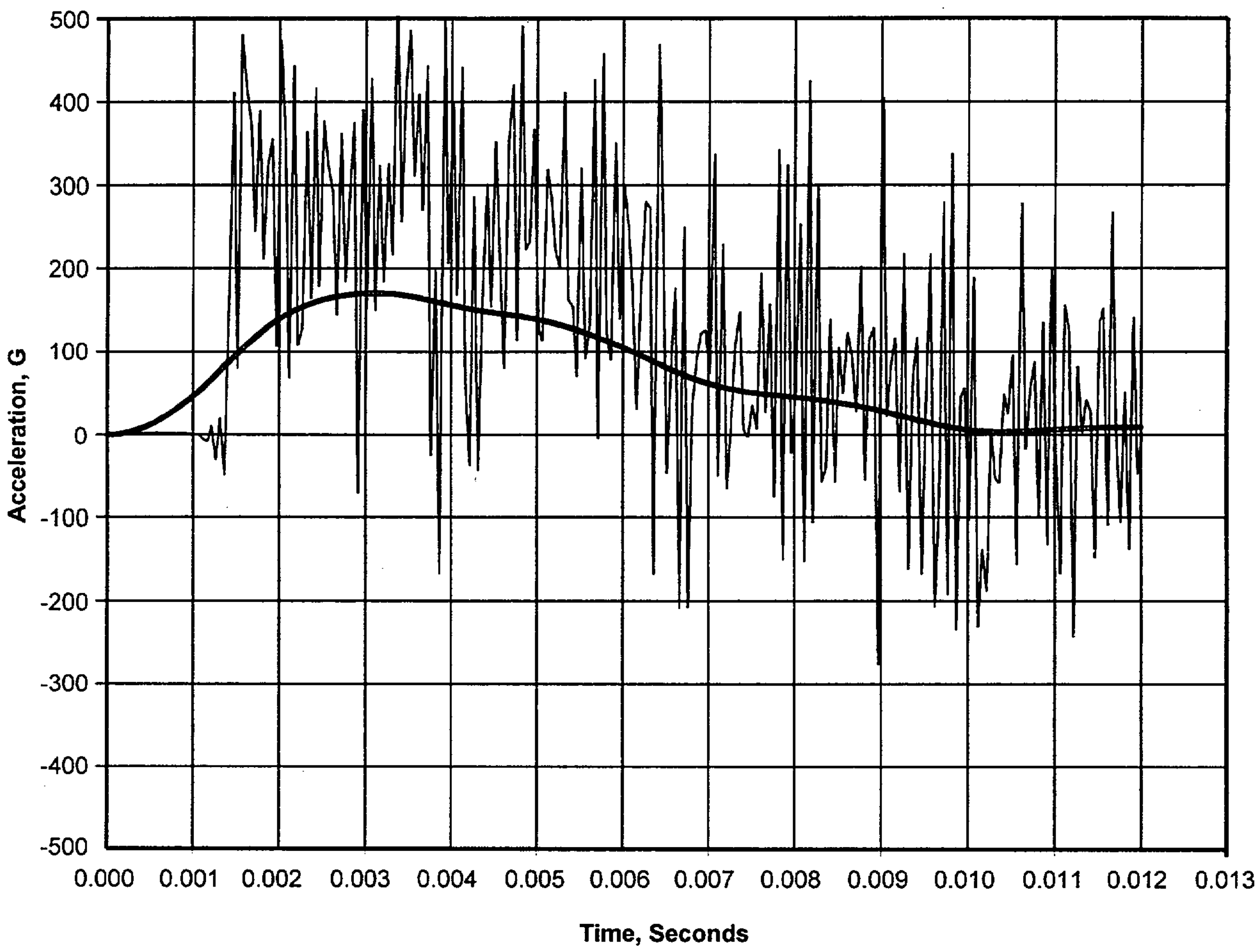
The top end drop and top corner drop test configurations used three accelerometers each. Data from all accelerometers used in the end and corner tests are considered in evaluating the test results.

For the 30-foot side drop performed at Sandia, six accelerometers were used—three at the top end of the model and three were attached to the bottom end of the cask model. These six accelerometer traces are contained in the response to RAI 2-50.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-51 (Continued)

Figure 2.51-1 Upper Impact Limiter Acceleration - 30-ft End Drop

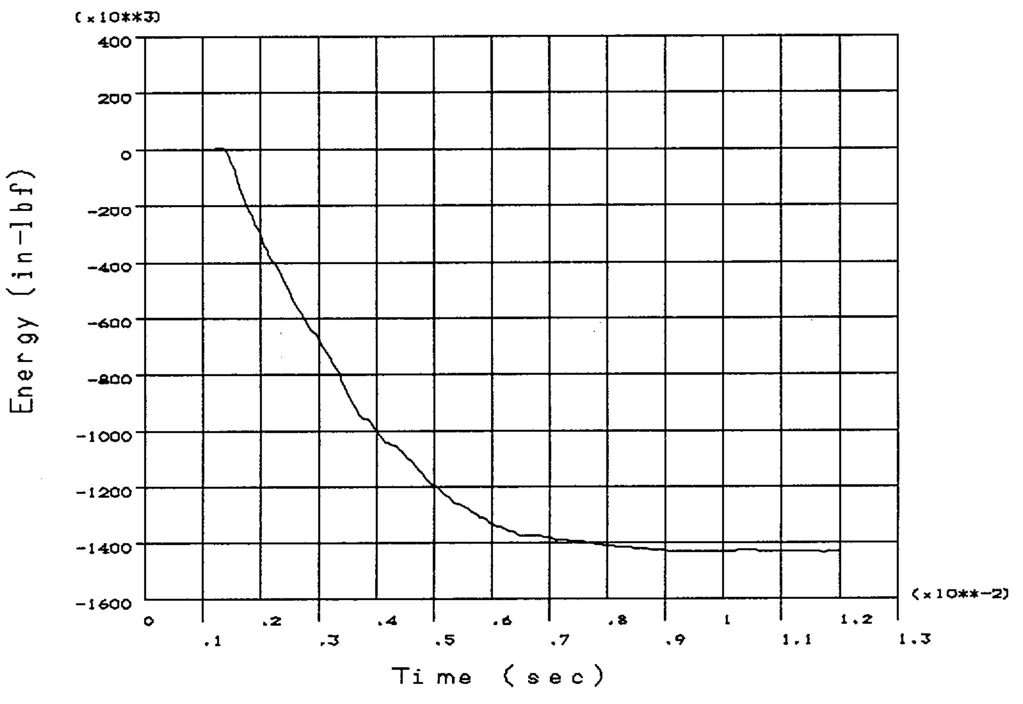


Accelerometer: end1

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-51 (Continued)

Figure 2.51-2 Upper Impact Limiter Energy - 30-ft End Drop

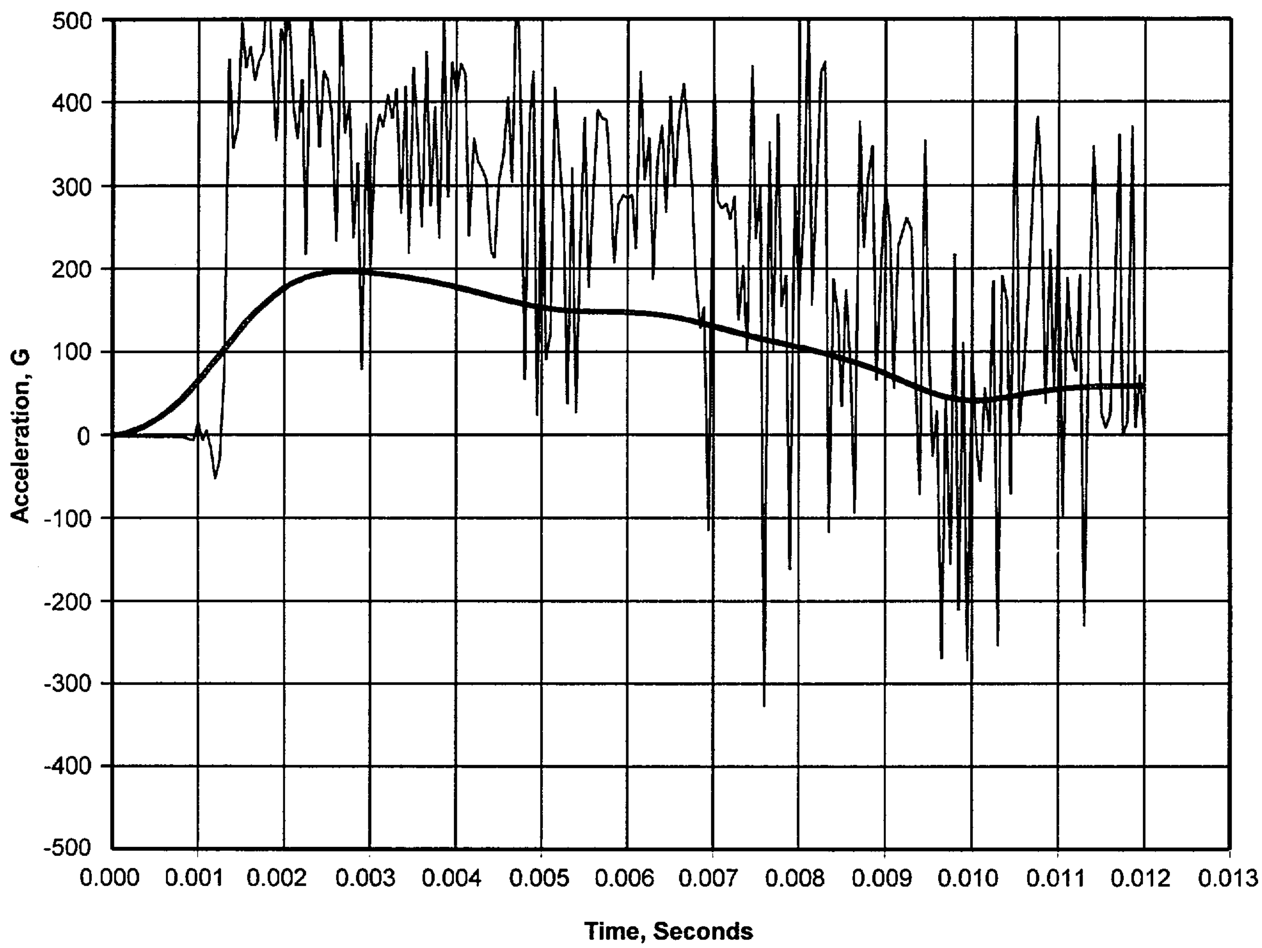


Accelerometer: end1

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-51 (Continued)

Figure 2.51-3 Upper Impact Limiter Acceleration - 30-ft End Drop

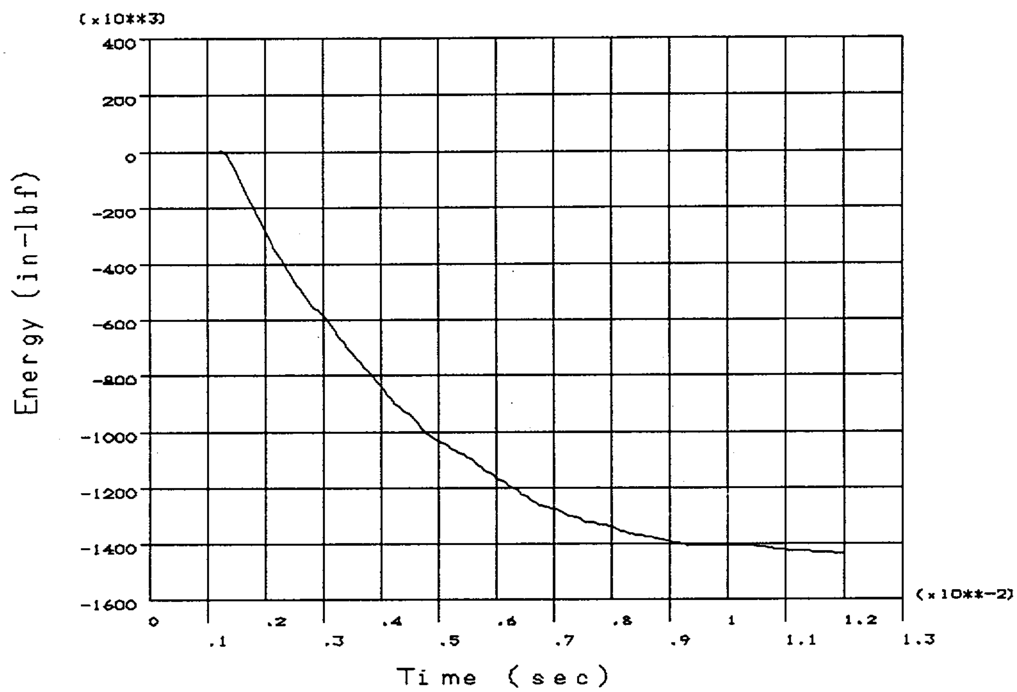


Accelerometer: end2

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-51 (Continued)

Figure 2.51-4 Upper Impact Limiter Energy - 30-ft End Drop

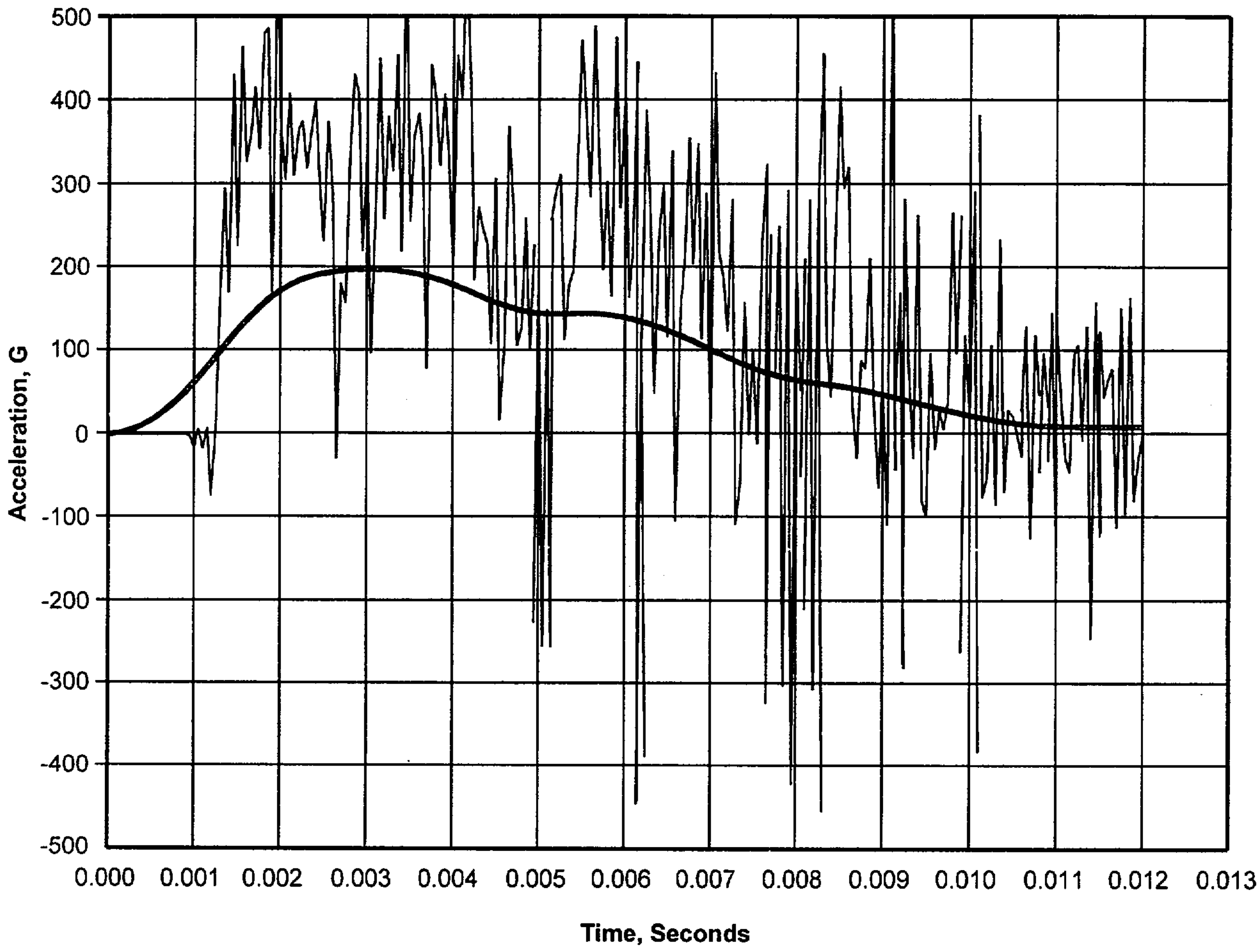


Accelerometer: end2

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-51 (Continued)

Figure 2.51-5 Lower Impact Limiter Acceleration - 30-ft End Drop

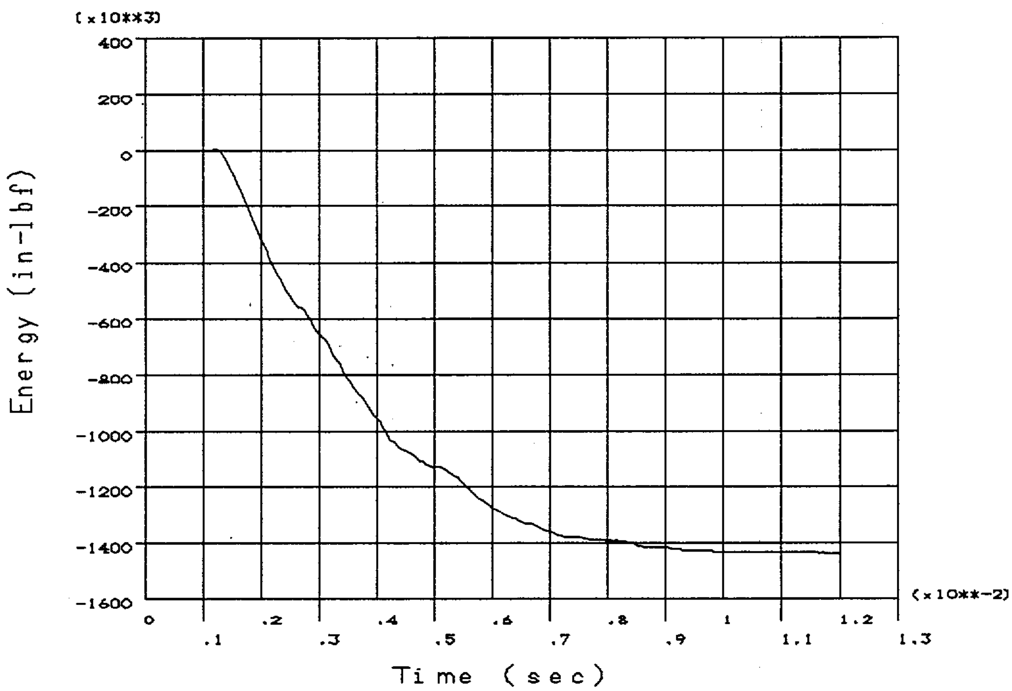


Accelerometer: end3

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-51 (Continued)

Figure 2.51-6 Lower Impact Limiter Energy - 30-ft End Drop

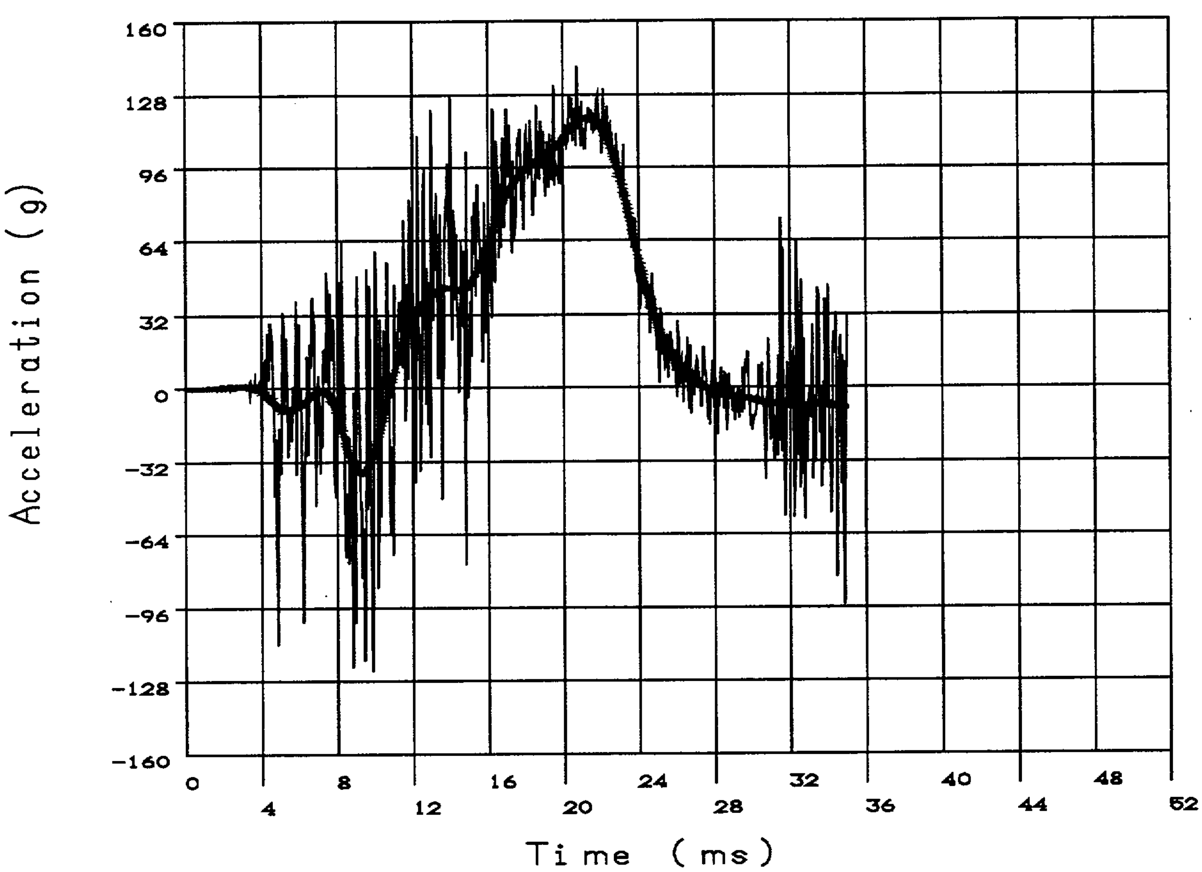


Accelerometer: end3

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-51 (Continued)

Figure 2.51-7 Corner Drop Unfiltered and Filtered Acceleration Data

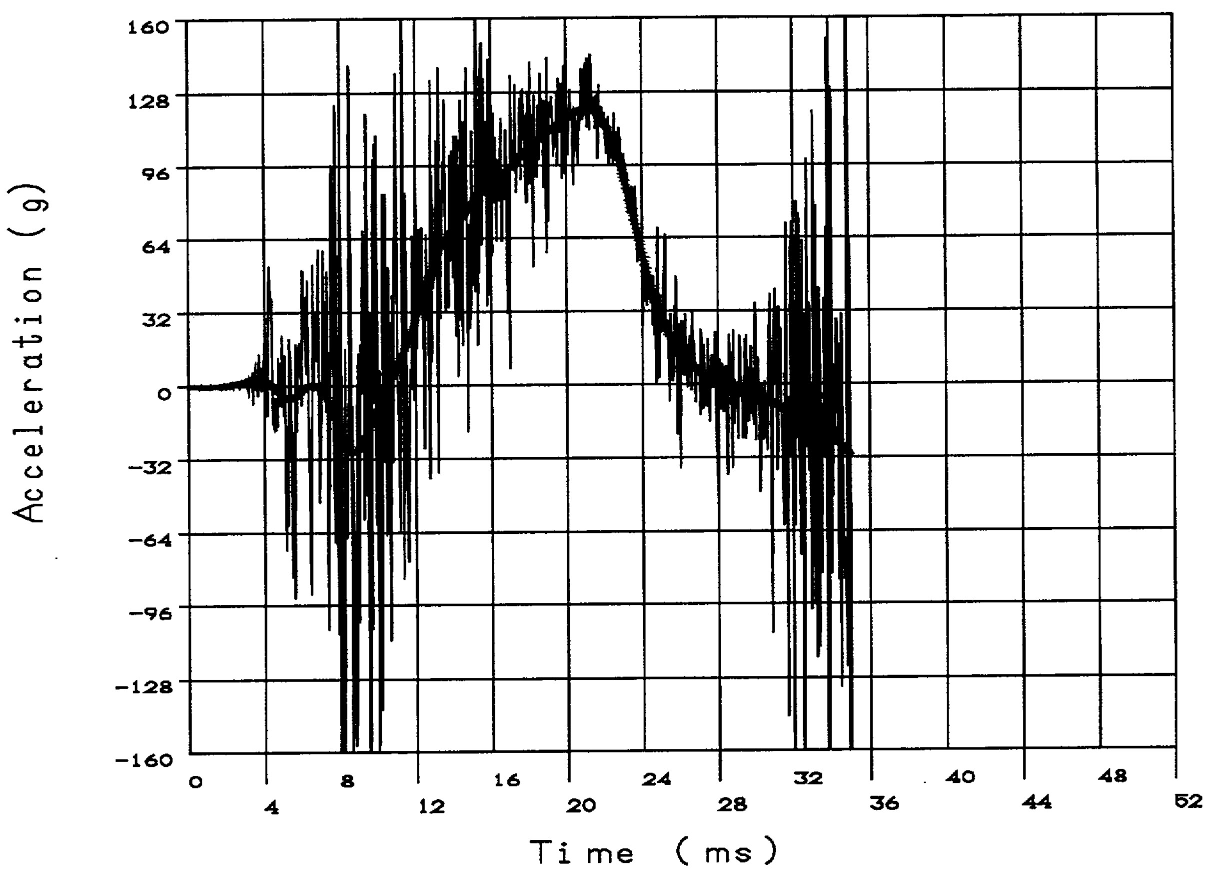


Accelerometer:Corner1

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-51 (Continued)

Figure 2.51-8 Corner Drop Unfiltered and Filtered Acceleration Data

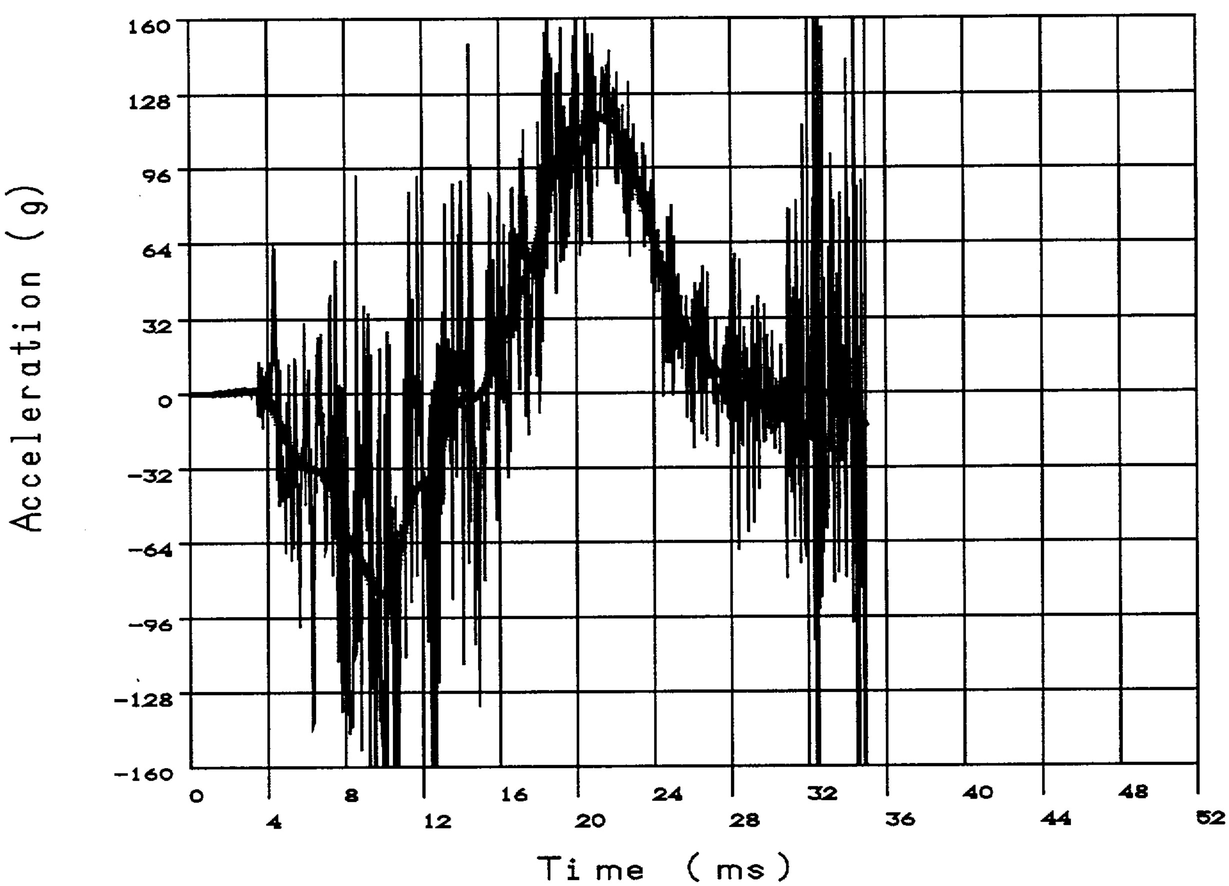


Accelerometer:Corner2

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-51 (Continued)

Figure 2.51-9 Corner Drop Unfiltered and Filtered Acceleration Data



Accelerometer:Corner3

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.10.3 Confirmatory Testing Program—UMS Impact Limiters and Attachments

2-52 Submit the force-deflection curves for the impact limiter models under the static crush test configurations for the side and oblique drops.

In addition to the end drop static test results presented in Figures 2.10.3-3 and -4, appropriate static test results should be shown to correlate adequately the RBCUBED calculated force-deflection curves of Figures 2.6.7.5-16 and -17, for the oblique and side drops, respectively. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the testing program intended for confirming the calculated package performance under the free drops of Sections 71.71(c)(7) and 71.73(c)(1).

NAC Response

The RBCUBED static analyses have been replaced by LS-DYNA dynamic analyses. The LS-DYNA analysis results are compared directly to the Oak Ridge and Sandia 30-ft drop test results and are included in Section 2.10.3. The following tables compare the test and analysis results:

Comparison of Quarter-Scale Test Results and confirmatory Test Data

UMS Cask model Drop Orientation	Quarter-Scale Drop Test Results (g)		LS-DYNA Prediction (g)		Design Basis Acceleration (g)
	Top Accelerometer	Bottom Accelerometer	Top Accelerometer	Bottom Accelerometer	
Top Corner	121	N/A	143	N/A	240
Top End	207	N/A	226	N/A	240
Side	190	198	220	213	240

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-52 (Continued)

Crush Depth Summary

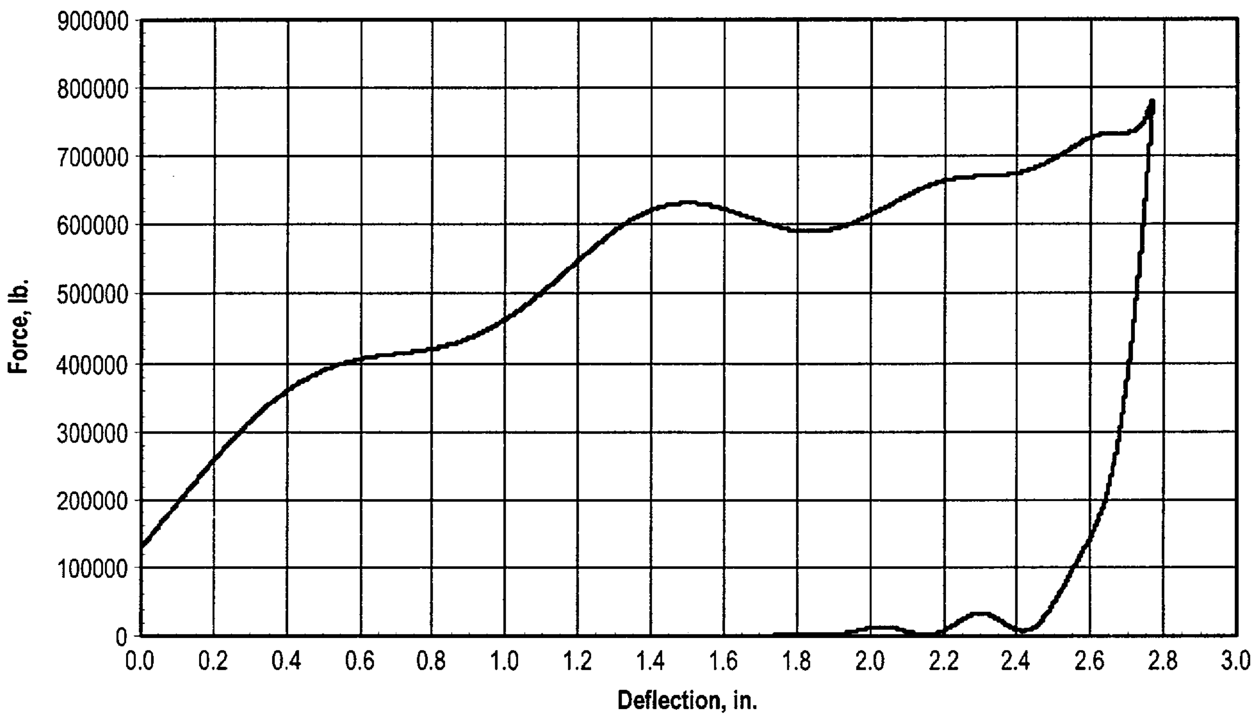
UMS® Cask Model Drop Orientation	Quarter-Scale Drop Test Results (inch)			LS-DYNA Prediction (inch)		
	Original Thickness	Final Thickness	Measured Crush Depth	Original Thickness	Final Thickness	Total Crush Depth
Top End Drop	—	—	2.00	—	—	2.21
Top Corner Drop	—	—	2.95	—	—	3.36
Side Drop–Under the trunnion	3.50	0.63	2.87	3.47	0.38	3.09
Side Drop–Bottom impact limiter	5.13	2.38	2.75	5.13	2.39	2.74

To provide complete information, the 30-ft side drop test force-displacement curve (Figure 2.52-1) was supplied by Sandia National Laboratory. The energy absorption capacity of the impact limiters for the side drop is discussed in Section 2.10.3.4.5. Based on the analyses provided in Section 2.6.7.5.7 (NAC Calculation EA790-2235), the maximum accelerations occur during the end and side drops. Therefore, the force-displacement curves for the corner and oblique angles are not provided.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-52 (Continued)

Figure 2.52-1 Quarter-Scale Side Drop Force-Displacement Curve (SNL March 2001)



NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.10.3 Confirmatory Testing Program—UMS Impact Limiters and Attachments

2-53 Clarify, as appropriate, the underlined typographical or editorial errors.

Pg. 2.10.3-30, maximum accelerations summary in the data correlation table, "[U]pper impact limiter (peak positive or negative g values)...86...49.57...50.95..."

The referenced SAR tables and figures suggest that some of the listed acceleration peak values are not related to the cask top-corner drop. Complete and accurate information should be presented, per Section 71.7(a).

NAC Response

The summary tables have been completely revised to compare the peak drop test accelerations to the LS-DYNA analysis predicted results. See response to RAI 2-52 for revised summary tables.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.11 Site-Specific Contents Structural Evaluation

2-54 Considering sectional (primary membrane and membrane-plus-bending), in lieu of nodal, stresses in the support disk ligaments, re-evaluate normalized stress ratios in Table 2.11.1.1-1 for the Maine Yankee consolidated fuel.

The PWR support disk ligaments are evaluated with sectional stresses for the design basis spent fuel assemblies. When normalized stress ratios are considered in comparing relative structural performance, a consistent evaluation approach should be maintained throughout the SAR, including the Maine Yankee consolidated fuel. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package structural performance under the conditions and tests of Sections 71.71 and 71.73.

NAC Response

The parametric study of the support disk presented in Section 2.11.1.1 is revised to consider the support disk sectional stresses in lieu of nodal stresses. The normalized stress ratios in Table 2.11.1.1-1 are revised based on the sectional stress results. The number of cases evaluated is reduced from 12 to 4, since consolidated fuel is restricted to one of the four corner locations of the basket. As shown in Table 2.11.1.1-1, the stresses in the support disk for this configuration are bounded by the stresses in the support disk for the design basis PWR configuration.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.11 Site-Specific Contents Structural Evaluation

2-55 Clarify the statement on Page 2.11.1-1, "[T]his study shows that a consolidated fuel assembly can be located in any position of the UMS PWR basket based on structural loading considerations."

Under a side drop, stresses in the support disk ligaments appear to be governed only by the locally applied equivalent inertia load of the design basis consolidated spent fuel assembly. As a result, because of the relatively large weight of the consolidated fuel lattice, some of the normalized stress ratios for the 12 fuel tube locations are expected to exceed 1.00, the stress ratio for Base Case. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package's structural performance under the conditions and tests of Sections 71.71 and 71.73.

<u>NAC Response</u>

Section 2.11.1.1 is revised to indicate that the consolidated fuel stored in a Maine Yankee fuel basket must be placed in one of the corner positions of the basket.

The stresses in the support disk ligaments during a side drop are governed predominantly by displacement (ovalization) of the disk, rather than the locally applied equivalent inertia load of a fuel assembly.

The pressure on the support disk ligament due to the inertia load (1g) of the UMS® System design basis PWR fuel assembly (including the fuel tube) is 12.26 psi. The thickness of the support disk is 0.5 inch. There are three different widths of the ligament: 0.875 inch, 1.0 inch and 1.5 inches, depending on the position within the support disk. The length of the ligament is 9.272 inches. Considering the support disk ligament to be a beam with both ends fixed, subjected to a 20g side impact condition, the maximum bending moment (M) and bending stress

**NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION**

NAC Response to RAI 2-55 (Continued)

(σ) in the ligament are:

Ligament Height (inch)	M (inch-kip)	S ($inch^3$)	σ (ksi)
0.875	0.8783	0.0638	13.77
1.0	0.8783	0.0833	10.54
1.5	0.8783	0.1875	4.7

In this table, $M = wL^2/12$, S is the Section Modulus, and σ is the bending stress (M / S).

Where:

w = the force per unit length (20g) on the ligament ($(0.01226 \times 0.5) \times 20 = 0.1226$ kips/inch)
L = the length of the ligament (9.272 inches)
$S = bt^2/6$, where b is the ligament thickness and t is the ligament width

As shown in the table, the maximum stress in the support disk ligament due to the locally applied inertia load is 13.77 ksi. This stress is well below the maximum stresses calculated by the three-dimensional canister/basket model for the side drop condition (see Section 2.6.13.6). As shown in Tables 2.6.13.6-3, 2.6.13.6-5, 2.6.13.6-7, 2.6.13.6-9, 2.6.13.6-11, 2.6.13.6-13, 2.6.13.6-15, and 2.6.13.6-17, the maximum P_m+P_b stress in the PWR support disk ligaments is 44.9 ksi, 52.4 ksi, 47.7 ksi and 56.9 ksi for the 0°, 18.22°, 26.28° and 45° basket drop orientations, respectively. Therefore, it is concluded that stresses in the support disk ligaments for a side impact are governed predominantly by the displacement (ovalization) of the disk.

The pressure on the support disk ligament due to equivalent inertia load (1g) of the Maine Yankee consolidated fuel, including the damaged fuel can and the fuel tube, is 17.0 psi. The consolidated fuel is limited to the corner positions of the basket, where the support disk ligament width is 1.5 inches.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-55 (Continued)

Using the formula above, the maximum bending stress in the ligament is calculated to be 6.5 ksi, an increase of only 1.8 ksi, compared with the maximum stress of 4.7 ksi for the UMS® design basis loading as shown in the previous table.

Since the total weight (≈ 35,500 lbs) on the basket for the configuration of 23 Maine Yankee standard fuel assemblies and one consolidated fuel lattice is much less than the total weight of 24 UMS® design basis fuel assemblies and fuel tubes (≈ 40,900 lbs), it is concluded that the maximum stress in the support disk for the Maine Yankee consolidated fuel configuration is bounded by the maximum stress in the support disk for the UMS® design basis configuration. This is further demonstrated by reperforming the analysis using the PWR support disk model for the governing case (45° basket orientation and thermal condition B) for the side drop condition (Section 2.6.13.6).

See also the response to RAI 2-56.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.11 Site-Specific Contents Structural Evaluation

2-56 Submit a stress summary table on maximum stresses in the support disk for location "Case 6" to demonstrate adequate stress margins for the corner-location preferential loading of the consolidated fuel.

An evaluation of normalized stress ratios, in Table 2.11.1-1, alone may not be sufficient to substantiate the SAR conclusion on maximum stresses in the support disk, and explicit stress margins should be considered for the evaluation. Complete and accurate information should be provided, per Section 71.7(a), for evaluating the package structural performance under the conditions and tests of Sections 71.71 and 71.73.

NAC Response

A support disk analysis is performed for the Maine Yankee fuel configuration consisting of 23 standard fuel assemblies and one consolidated fuel assembly, using the two-dimensional PWR support disk model for the governing case (45° basket orientation and thermal condition B) for the side drop condition (Section 2.6.13.6). The loading condition corresponds to Case 1 of the updated parametric study presented in Table 2.11.1.1-1 and discussed in Section 2.11.1.1 (equivalent to Case 6 in the previous study).

The analysis results of the P_m and $P_m + P_b$ stresses are summarized in Tables 2.11.1.1-2 and 2.11.1.1-3, respectively. The minimum Margins of Safety for the P_m and $P_m + P_b$ stresses are +0.82 and +0.24, respectively.

The minimum Margins of Safety for the corresponding analysis for the UMS® System design basis PWR configuration are +0.79 and +0.19 for P_m and $P_m + P_b$ stresses, respectively (see Tables 2.6.13.6-16 and 2.6.13.6-17). This comparison further substantiates the conclusion of the

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 2-56 (Continued)

parametric study based on the normalized stress ratios using a two-dimensional model (Table 2.11.1.1-1) that the maximum stress in the UMS® basket support disk loaded with Maine Yankee fuel, including one consolidated fuel lattice, is bounded by the design basis PWR fuel evaluation of the support disks.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 2: STRUCTURAL

Section 2.11 Site-Specific Contents Structural Evaluation

2-57 Clarify, as appropriate, the underlined typographical or editorial errors.

Pg. 2.11.2-1, "[T]he center of gravity for...GTCC waste canister...identical to the C.G. for the transport cask containing PWR Class 1 fuel (107.99 inches) as shown in Table 2.2-1."

Table 2.2-1 lists the location of C.G. at 106.60 inches from the bottom of the cask body; complete and accurate information should be provided, per Section 71.7(a).

NAC Response

Section 2.11.2.1 is revised to clarify the comparison between the center of gravity (C.G.) for the Transport Cask with the PWR fuel Class 1 canister and the Greater Than Class C (GTCC) waste canister. Table 2.2-3 is added to Section 2.2 to provide the weight and CG information for the GTCC waste configuration.

See the response to RAI 2-8.

List of Effective Pages

Master Table of Contents

Chapter 1

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

Chapter 3

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

Chapter 6

List of Effective Pages (Continued)

List of Effective Pages (Continued)

List of Effective Pages (Continued)

Chapter 7

List of Effective Pages (Continued)

Master Table of Contents (Continued)

Master Table of Contents (Continued)

Master Table of Contents (Continued)

Master Table of Contents (Continued)

Master Table of Contents (Continued)

Master Table of Contents (Continued)

Master Table of Contents (Continued)

Master Table of Contents (Continued)

1.3.4 License Drawings

This section contains the License Drawings pertinent to the Universal Transport Cask. The dimensions indicated on the drawings are generally limited to one significant digit past the decimal point. Note that analysis of systems or components may present dimensions with additional significant digits based on more detailed engineering drawings.

Drawing No.	Rev. No.	Title
790-209	1	Impact Limiter Assembly-Upper, Cask, NAC-UMS®
790-210	1	Impact Limiter Assembly-Lower, Cask, NAC-UMS®
790-500	2	Assembly, Universal Transport Cask, Overpack, NAC-UMS®
790-501	3	Canister/Basket Assembly Table, NAC-UMS®
790-502	4	Cask Body, Transport Cask, NAC-UMS®
790-503	1	Lid Assembly, NAC-UMS® Cask
790-504	1	Port Coverplate Assembly, NAC-UMS®
790-505	1	Lifting Trunnion, NAC-UMS®
790-508	2	Misc. Details, Transport Cask, NAC-UMS®
790-509	2	Nameplates - NAC-UMS®
790-516	1	Package Assembly, Universal Transport Cask (UTC), NAC-UMS®
790-519	0	Package Assembly, Transport, Universal Transport Cask (UTC), NAC-UMS®
790-520	2	Spacers, Universal Transport Cask, NAC-UMS®
790-570	3	Fuel Basket Assembly, 56 Element BWR, NAC-UMS®
790-571	2	Bottom Weldment, Fuel Basket, 56 Element BWR, NAC-UMS®

Licensed Drawings (Continued)

Drawing No.	Rev. No.	Title
790-572	4	Top Weldment, Fuel Basket, 56 Element BWR, NAC-UMS®
790-573	7	Support Disk and Misc. Basket Details, 56 Element BWR, NAC-UMS®
790-574	3	Heat Transfer Disk Fuel Basket, 56 Element BWR, NAC-UMS®
790-575	4	BWR Fuel Tube, NAC-UMS®
790-581	5	PWR Fuel Tube, NAC-UMS®
790-582	7	Shell Weldment, Canister, NAC-UMS®
790-583	4	Assembly, Drain Tube, Canister, NAC-UMS®
790-584	11	Details, Canister, NAC-UMS®
790-585	8	Transportable Storage Canister (TSC), NAC-UMS®
790-591	2	Bottom Weldment, Fuel Basket, 24 Element PWR, NAC-UMS®
790-592	5	Top Weldment, Fuel Basket, 24 Element PWR, NAC-UMS®
790-593	4	Support Disk and Misc. Basket Details, 24 Element PWR, NAC-UMS®
790-594	2	Heat Transfer Disk, Fuel Basket, 24 Element PWR, NAC-UMS®
790-595	5	Fuel Basket Assembly, 24 Element PWR, NAC-UMS®
790-605	5	BWR Fuel Tube, Over-Sized Fuel, NAC-UMS®
790-611	3	GTCC Waste Basket, Maine Yankee, NAC-UMS®
790-612	3	GTCC Waste Canister, Maine Yankee, NAC-UMS®

FIGURE WITHHELD UNDER 10 CFR 2.390

DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5-94
UNSPECIFIED DIMENSIONS AND TOLERANCES SHOWN BELOW.
DIMENSIONS ARE IN INCHES. FRACTIONAL TOLERANCE: ±1/8

SYM.	GEOMETRY	.XXX	TOL.	.XX	TOL.
		UNDER 3	±.003	UNDER 6	±.02
	FLATNESS	3-12	±.005	6-18	±.03
	STRAIGHTNESS	OVER 12	±.010	OVER 18	±.06
		.X	±.1	ANGLES ±0.5°	
	ANGULARITY	ALL UNSPECIFIED TOOL RADII: .015 - .030			
	PERPENDICULARITY	BREAK ALL SHARP CORNERS .015 - .030			
	PARALLELISM	ALL UNSPECIFIED MACHINED SURFACES SHALL BE [symbol] OR BETTER			
	CONCENTRICITY	NEXT ASSEMBLY:			
	TRUE POSITION	DRAWING TYPE: LICENSE			

GROUP	NAME	DATE
PREPARER	R. [illegible]	3-22-01
CHECKER	[illegible]	3/24/01
PROJECT MANAGER	[illegible]	[illegible]
DIRECTOR DESIGN AND ANALYSIS	[illegible]	3-23-01
DIRECTOR, LICENSING	[illegible]	3/27/01
VICE PRESIDENT, QUALITY	[illegible]	3/29/01

MISC. DETAILS,
TRANSPORT CASK
NAC-UMS®

PROJECT 790	DRAWING 508	REV 2
SCALE 1/1	EST.WT.	SH 1 OF 2 — 5:34PM 3-22-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL

MISC. DETAILS, TRANSPORT CASK NAC-UMS®

PROJECT 790	DRAWING 508	REV 2
SCALE 1/1	EST.WT.	SH 2 OF 2

FIGURE WITHHELD UNDER 10 CFR 2.390

DIMENSIONING AND TOLERANCING SHALL BE PER ANSI Y14.5-82
UNSPECIFIED DIMENSIONS AND TOLERANCES SHOWN BELOW.
DIMENSIONS ARE IN INCHES. FRACTIONAL TOLERANCE: ±1/8

SYM.	GEOMETRY	.XXX	TOL.	.XX	TOL.
		UNDER 3		UNDER 6	±.04
	FLATNESS	3-12		6-18	±.06
	STRAIGHTNESS	OVER 12		OVER 18	±.09
		.X	±.1	ANGLES ±.5°	
	ANGULARITY	ALL UNSPECIFIED TOOL RADII: .01 - .03			
	PERPENDICULARITY	BREAK ALL SHARP CORNERS .01 - .03			
	PARALLELISM	ALL UNSPECIFIED MACHINED SURFACES SHALL BE ▽ OR BETTER			
	CONCENTRICITY	NEXT ASSEMBLY: 790-585			
	TRUE POSITION	DRAWING TYPE: LICENSE			

GROUP	NAME	DATE
PREPARER	[illegible]	3/22/01
CHECKER	[illegible]	3-22-01
PROJECT MANAGER	[illegible]	3/24/01
DIRECTOR DESIGN AND ANALYSIS	[illegible]	3-27-01
DIRECTOR, LICENSING	[illegible]	3/27/01
VICE PRESIDENT, QUALITY	[illegible]	3/28/01

SHELL WELDMENT
CANISTER
NAC-UMS®

PROJECT 790		DRAWING 582	REV 7
SCALE 1/8	EST. WT.	SH 1 OF 1	4:46PM 3-22-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5-94
UNSPECIFIED DIMENSIONS AND TOLERANCES SHOWN BELOW.
DIMENSIONS ARE IN INCHES. FRACTIONAL TOLERANCE: ±1/8

SYM.	GEOMETRY	.XXX	TOL.	.XX	TOL.
		UNDER 3	±.003	UNDER 6	±.02
▱	FLATNESS	3-12	±.005	6-18	±.03
—	STRAIGHTNESS	OVER 12	±.010	OVER 18	±.06
		.X	±.1	ANGLES ±0.5°	
∠	ANGULARITY	ALL UNSPECIFIED TOOL RADII: .015 - .030			
⊥	PERPENDICULARITY	BREAK ALL SHARP CORNERS .015 - .030			
//	PARALLELISM	ALL UNSPECIFIED MACHINED SURFACES SHALL BE ▽/OR BETTER			
◎	CONCENTRICITY	NEXT ASSEMBLY: 790-085			
⊕	TRUE POSITION	DRAWING TYPE: LICENSE			

GROUP	NAME	DATE
PREPARED	[illegible]	3/26/01
CHECKED	R. [illegible]	3-28-01
PROJECT MANAGER	[illegible]	3/27/01
DIRECTOR DESIGN AND ANALYSIS	[illegible]	3-27-01
DIRECTOR LICENSING	[illegible]	3/27/01
VICE PRESIDENT QUALITY	[illegible]	3/29/01

DETAILS,
CANISTER
NAC-UMS®

PROJECT 790		DRAWING 584	REV 11
SCALE 1/8	EST.WT.	SH 1 OF 3	1:53PM 3-26-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL

DETAILS,
CANISTER
NAC–UMS®

PROJECT 790		DRAWING 584	REV 11
SCALE 1/8	EST.WT.	SH 2 OF 3	9:59AM 3-27-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL

DETAILS,
CANISTER
NAC–UMS®

PROJECT 790		DRAWING 584	REV 11
SCALE 1/8	EST.WT.	SH 3 OF 3	4:46PM 3-22-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5-94
UNSPECIFIED DIMENSIONS AND TOLERANCES SHOWN BELOW.
DIMENSIONS ARE IN INCHES. FRACTIONAL TOLERANCE: ±1/8

SYM.	GEOMETRY	.XXX	TOL.	.XX	TOL.
	FLATNESS	UNDER 3	±.003	UNDER 6	±.02
	STRAIGHTNESS	3-12	±.005	6-18	±.03
	ANGULARITY	OVER 12	±.010	OVER 18	±.06
	PERPENDICULARITY	.X	±.1	ANGLES ±0.5°	
	PARALLELISM	ALL UNSPECIFIED TOOL RADII: .015 - .030			
	CONCENTRICITY	BREAK ALL SHARP CORNERS .015 - .030			
	TRUE POSITION	ALL UNSPECIFIED MACHINED SURFACES SHALL BE 250/OR BETTER			

NEXT ASSEMBLY: 790-590/516
DRAWING TYPE: LICENSE

GROUP	NAME	DATE
PREPARER		3/26/01
CHECKER	R. Walker	3-26-01
PROJECT MANAGER		3/26/01
DIRECTOR DESIGN AND ANALYSIS		3-27-01
DIRECTOR LICENSING		3/27/01
VICE PRESIDENT QUALITY		3/29/01

INTERNATIONAL

TRANSPORTABLE STORAGE CANISTER, (TSC) NAC-UMS®

PROJECT 790 | DRAWING 585 | REV 8
SCALE 1/8 | EST.WT. | SH 1 OF 2 | 1:35PM 3-26-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL

TRANSPORTABLE STORAGE CANISTER, (TSC) NAC-UMS®

PROJECT 790		DRAWING 585	REV 8
SCALE 1/8	EST.WT.	SH 2 OF 2	3-22-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5–94
UNSPECIFIED DIMENSIONS AND TOLERANCES SHOWN BELOW.
DIMENSIONS ARE IN INCHES. FRACTIONAL TOLERANCE: ±1/8

SYM.	GEOMETRY	.XXX	TOL.	.XX	TOL.
⏥	FLATNESS	UNDER 3	±.003	UNDER 6	±.02
—	STRAIGHTNESS	3–12	±.005	6–18	±.03
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06
⊥	PERPENDICULARITY	.X	±.1	ANGLES ±0.5°	
//	PARALLELISM	ALL UNSPECIFIED TOOL RADII: .015 – .030			
◎	CONCENTRICITY	BREAK ALL SHARP CORNERS .015 – .030			
⌖	TRUE POSITION	ALL UNSPECIFIED MACHINED SURFACES SHALL BE ▽ OR BETTER			

NEXT ASSEMBLY: 790–595

DRAWING TYPE: LICENSE

GROUP	NAME	DATE
PREPARER	[illegible]	3/22/01
CHECKER	R. M[illegible]	3-22-01
PROJECT MANAGER	[illegible]	3/26/01
DIRECTOR DESIGN AND ANALYSIS	[illegible]	3-27-01
DIRECTOR, LICENSING	[illegible]	3/27/01
VICE PRESIDENT, QUALITY	Roy W. Bass	3/28/01

INTERNATIONAL

TOP WELDMENT,
FUEL BASKET,
24 ELEMENT PWR
NAC–UMS®

PROJECT 790		DRAWING 592	REV 5
SCALE 1/5	EST.WT. 725#	SH 1 OF 1	4:25PM 3-22-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

INTERNATIONAL

DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5–94
UNSPECIFIED DIMENSIONS AND TOLERANCES SHOWN BELOW.
DIMENSIONS ARE IN INCHES. FRACTIONAL TOLERANCE: ±1/8

SYM.	GEOMETRY	.XXX	TOL.	.XX	TOL.
		UNDER 3	±.003	UNDER 6	±.02
	FLATNESS	3–12	±.005	6–18	±.03
	STRAIGHTNESS	OVER 12	±.010	OVER 18	±.06
		.X	±.1	ANGLES ±0.5°	
	ANGULARITY	ALL UNSPECIFIED TOOL RADII: .015 – .030			
	PERPENDICULARITY	BREAK ALL SHARP CORNERS .015 – .030			
	PARALLELISM	ALL UNSPECIFIED MACHINED SURFACES SHALL BE 125/ OR BETTER			
	CONCENTRICITY	NEXT ASSEMBLY: 790–585			
	TRUE POSITION	DRAWING TYPE: LICENSE			

GROUP	NAME	DATE
PREPARER	[illegible]	3/26/01
CHECKER	R. Walker	3-26-01
PROJECT MANAGER	[illegible]	3/26/01
DIRECTOR DESIGN AND ANALYSIS	[illegible]	3-27-01
DIRECTOR, LICENSING	[illegible]	3/27/01
VICE PRESIDENT, QUALITY	[illegible]	3/29/01

FUEL BASKET ASSEMBLY,
24 ELEMENT PWR
NAC–UMS®

PROJECT 790 | DRAWING 595 | REV 5

SCALE 1/6 | EST.WT. | SH 1 OF 2 | 2:47PM 3-26-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL

FUEL BASKET ASSEMBLY,
24 ELEMENT PWR
NAC–UMS®

PROJECT 790		DRAWING 595	REV 5
SCALE 1/6	EST.WT.	SH 2 OF 2	1:17PM 3-22-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

DIMENSIONING AND TOLERANCING SHALL BE PER ANSI Y14.5-82
UNSPECIFIED DIMENSIONS AND TOLERANCES SHOWN BELOW.
DIMENSIONS ARE IN INCHES. FRACTIONAL TOLERANCE: ±1/8

SYM.	GEOMETRY	.XXX	TOL.	.XX	TOL.
	FLATNESS	UNDER 3		UNDER 6	±.04
	STRAIGHTNESS	3-12		6-18	±.06
	ANGULARITY	OVER 12		OVER 18	±.09
	PERPENDICULARITY	.X	±.1	ANGLES ±.5°	
	PARALLELISM	ALL UNSPECIFIED TOOL RADII: .01 - .03			
	CONCENTRICITY	BREAK ALL SHARP CORNERS .01 - .03			
	TRUE POSITION	ALL UNSPECIFIED MACHINED SURFACES SHALL BE ▽ OR BETTER			

NEXT ASSEMBLY: 790-612
DRAWING TYPE: LICENSE

GROUP	NAME	DATE
PREPARER	[signature]	3/22/01
CHECKER	[signature]	3·22·01
PROJECT MANAGER	[signature]	[illegible]
DIRECTOR DESIGN AND ANALYSIS	[signature]	3·27·01
DIRECTOR, LICENSING	[signature]	3/27/01
VICE PRESIDENT, QUALITY	[signature]	3/28/01

GTCC WASTE BASKET,
MAINE YANKEE,
NAC-UMS®

PROJECT 790		DRAWING 611	REV 3
SCALE 1/10	EST.WT.	SH 1 OF 2	1:27PM 3-22-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL

GTCC WASTE BASKET,
MAINE YANKEE,
NAC–UMS®

PROJECT 790		DRAWING 611	REV 3
SCALE 1/10	EST.WT.	SH 2 OF 2	1:27PM 3-22-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5-94
UNSPECIFIED DIMENSIONS AND TOLERANCES SHOWN BELOW.
DIMENSIONS ARE IN INCHES. FRACTIONAL TOLERANCE: ±1/8

SYM.	GEOMETRY	.XXX	TOL.	.XX	TOL.
⏥	FLATNESS	UNDER 3	±.003	UNDER 6	±.02
		3-12	±.005	6-18	±.03
—	STRAIGHTNESS	OVER 12	±.010	OVER 18	±.06
		.X	±.1	ANGLES ±0.5°	
∠	ANGULARITY	ALL UNSPECIFIED TOOL RADII: .015 - .030			
⊥	PERPENDICULARITY	BREAK ALL SHARP CORNERS .015 - .030			
//	PARALLELISM	ALL UNSPECIFIED MACHINED SURFACES SHALL BE ▽ OR BETTER			
◎	CONCENTRICITY	NEXT ASSEMBLY: 790-590/516			
⊕	TRUE POSITION	DRAWING TYPE: LICENSE			

GROUP	NAME	DATE
PREPARER	[illegible]	3/27/01
CHECKER	R. Walker	3-27-01
PROJECT MANAGER	[illegible]	3/27/01
DIRECTOR DESIGN AND ANALYSIS	[illegible]	3-28-01
DIRECTOR, LICENSING	[illegible]	3/28/01
VICE PRESIDENT, QUALITY	[illegible]	3/28/01

GTCC WASTE CANISTER,
MAINE YANKEE,
NAC-UMS®

PROJECT 790		DRAWING 612	REV 3
SCALE 1/10	EST.WT.	SH 1 OF 2	5:48PM 3-27-2001

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL				
GTCC WASTE CANISTER, MAINE YANKEE, NAC-UMS®				
PROJECT 790		DRAWING 612		REV 3
SCALE 1/10	EST.WT.	SH 2 OF 2		4:21PM 3-22-2001