Westinghouse

Westinghouse Electric Company
Nuclear Fuel
Columbia Fuel Site
P.O. Drawer R
Columbia, South Carolina 29250
USA

U. S. Nuclear Regulatory Commission
Attn: Mr. Stewart Brown
Package Certification Section
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555

Direct tel: (803) 647 3552
Direct fax: (803) 695 4164
e-mail: Kentna@westinghouse.com

Our ref: NMS-NRC-04-009
Your Ref: NRC LTR Aug 26, 2004

Mr. Brown:

October 15, 2004

Subject: CERTIFICATE OF COMPLIANCE NO. 9297 FOR THE MODEL NO. TRAVELLER PACKAGE, RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)

Attached please find Westinghouse Electric Company's response to NRC Request for Additional Information (RAI) for the Traveller package for Sections 2, 3 and 7. Responses to the remaining questions will be forwarded by separate letter.

Please be aware that it is our intention to answer the RAI questions by (1) providing a letter (such as this) which gives the NRC questions followed by the Westinghouse response, and (2) submitting a revised License Application. The License Application will be sent when all RAI questions have been answered.

Please direct any questions to the undersigned at (803) 647-3552.

Sincerely,

WESTINGHOUSE ELECTRIC COMPANY, LLC

Norman A. Kent

Norman A. Kent
Manager Transport Licensing and Regulatory Compliance
Nuclear Material Supply

Enclosures:
Enclosure 1: Response to NRC RAI questions for Section 2
Enclosure 2: Response to NRC RAI questions for Section 3
Enclosure 3: Response to NRC RAI questions for Section 7

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Enclosure 1: Response to NRC RAI questions for Section 2

The following table indicates which questions are provided below.

2-1	Yes	2-16	No ✓
2-2	Yes	2-17	No ✓
2-3	Yes	2-18	Yes ✓
2-4	No ✓	2-19	Yes ✓
2-5	Yes ✓	2-20	No ✓
2-6	Yes ✓	2-21	Yes ✓
2-7	No ✓	2-22	No ✓
2-8	No ✓	2-23	No ✓
2-9	Yes ✓	2-24	No ✓
2-10	No ✓	2-25	Yes ✓
2-11	No ✓	2-26	No ✓
2-12	No ✓	2-27	Yes ✓
2-13	No ✓	2-28	Yes ✓
2-14	Yes ✓	2-29	Yes ✓
2-15	No ✓		

Enclosure 2: Response to NRC RAI questions for Section 3

All the questions have been answered for Section 3.

Enclosure 3: Response to NRC RAI questions for Section 7

All the questions have been answered for Section 7.

Request for Additional Information
Model No. Traveller
Docket No. 71-9297

By application dated April 1, 2004, Westinghouse Electric Company requested a Certificate of Compliance for the Model No. Traveller package. This request identifies additional information needed by the Nuclear Regulatory Commission staff (the staff) in connection with its review of the safety analysis report (SAR). The requested information is listed by chapter number and title in the SAR. NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material," was used for this review. This request describes information needed by the staff for it to complete its review of the SAR and to determine whether the applicant has demonstrated compliance with regulatory requirements.

Chapter 2 Structural Evaluation

2-1 Page 2-1. Supplement the discussion provided in Section 2.1.1, first paragraph, to include justification for the bolt performance criteria. The current discussion states, "[p]ositive closure of the Outerpack is accomplished by means of high strength stainless bolts. ... [b]oth are below the bolt's ultimate strength." It is not clear from this information as to how the ultimate strength was considered when analyzing the closure function of the Outerpack.
This information is required in accordance with 10 CFR Part 71.33 which states that applications must include a description in sufficient detail to identify the package accurately and provide a sufficient basis for evaluation of the package.

Westinghouse Response:

The following text has been added to Section 2.1.1:

The design loadings for both packages are below the ultimate design loads for the Outerpack bolts. The worst case forces for the package are presented in Section 2.12.3.2.2, Horizontal Side Drops, and a discussion regarding the design allowable is presented in Section 2.12.3.7, Evaluation, Analysis and Detailed Calculations, and Section 2.12.3.9, Bolt Factor of Safety Calculation. Further evidence of the adequacy of the Outerpack bolts is demonstrated through 9m drop testing whereby only one (1) Outerpack bolt failed in a total of nine (9) 9m drop tests. The single bolt that failed did so as a result of direct impact with the drop pad.

2-2 Clarify the apparent discrepancy related to the number of hex head bolts required to fasten together the top and bottom Outerpack halves. Item 1, Bill of Materials, Drawing No. 10004E58, Rev. 1, specifies 48 bolts, which is twice as many as that discussed in Section 2.1.1.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

Westinghouse Response:

The following text has been added to Section 2.1.1:

There are 48 bolts ¾-inch bolts in the Outerpack, 24 attaching the hinge sections to the lower Outerpack and 24 attaching the upper Outerpack to the hinge sections. To remove the upper Outerpack, the 24 bolts must be removed. In the preferred approach, the Outerpack is opened when it is in a vertical orientation by removing the 12 bolts attaching the upper Outerpack to the hinges on one side. This allows the upper Outerpack to be opened on the other hinge sections, like a door.

2-3 Revise Section 2.6.5 to include an evaluation of vibration frequencies of the Clamshell-shock mount system to ensure that no resonant vibration conditions could occur yet result in damage to the Clamshell and its contents during normal conditions of transport.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.71(c)(5).

Westinghouse Response:

The following text and figure have been added to Section 2.6.5:

There are several natural frequencies of the shock mount system depending on direction of movement. The dominant frequency is for vertical movement. This frequency is between 5.9 and 6.7 Hz (for Traveller XL) depending on the weight of the fuel assembly being transported. The fore and aft pitch frequency is slightly higher (6.9-7.9 Hz) but has a lower amplitude. Road tests have been performed with the suspension system to measure amplitudes during shipping. Figure 2-1A is characteristic of the results seen. When the truck travels over a bump, the clamshell initially sees relatively large accelerations (2-3 g's) but this oscillation quickly damps out to accelerations less than 1 g. This 300 mi trip involved approximately five and a half hours on the road with 1.4×10^5 total cycles.

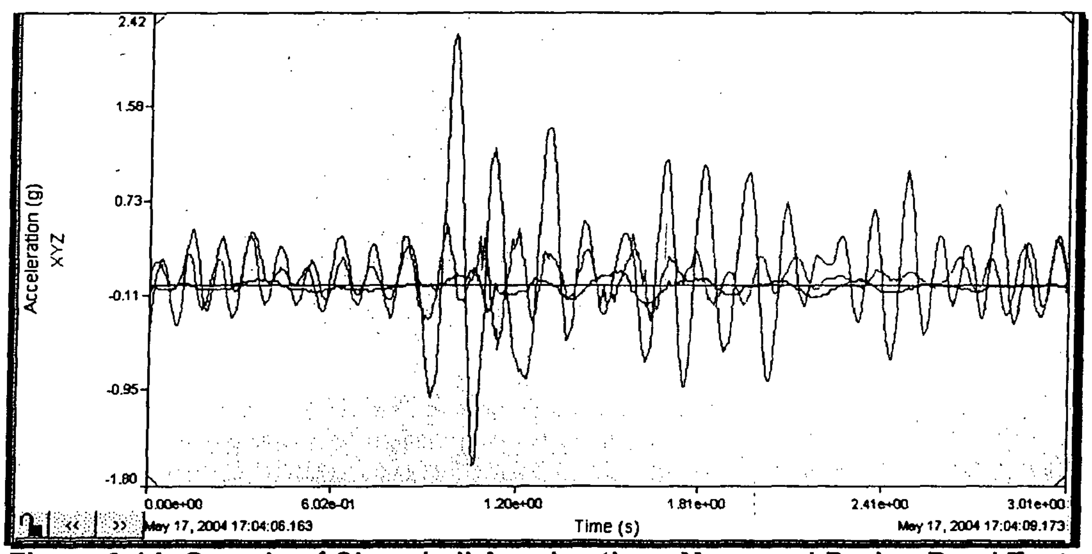

Figure 2-1A Sample of Clamshell Accelerations Measured During Road Test (May 11, 2004)

2-4 Provide design drawing details for the polyethylene moderator block, including the 26-gage stainless steel sheet covering and its attachment features to the Outerpack. Proper sheathing is noted as a means to prevent ignition of the polyethylene blocks during a fire accident (Table 2-5, Page 2-19). As such, design features of the polyethylene moderator blocks, including their attachment to the inner Outerpack, should be properly documented in the application.

This information is being requested in accordance with the provisions of 10 CFR 71.33 which requires an application to include a description in sufficient detail to identify the package accurately and provide sufficient basis for evaluation of the package.

2-5 Provide drawing details for the design changes introduced to the Certification Test Unit drop tests to improve performance of the package, including welding of the impact limiter pillow to the Outerpack liner plate and modification of the quick release pin. Changes to the packaging features that are important to safety should properly be presented in design drawings (Table 2-5, Page 2-22).

This information is being requested in accordance with the provisions of 10 CFR 71.33 which requires an application to include a description in sufficient detail to identify the package accurately and provide sufficient basis for evaluation of the package.

<u>Westinghouse Response</u>:

The following text and figures have been added to Table 2-5:

The figure below (Figure 2-1B) shows the impact limiter, or Pillow, assembly (shown without insulation). This assembly is shown installed in the Traveller package bottom (the configurations are the same for STD and XL packages) in Figure 2-1C. The weld between the bottom plate (yellow) and the puncture plate (red) is also shown. During testing this weld failed as expected, however, it did not completely allow the components to separate. This design change weakens the bottom plate by reducing its thickness to a nominal 0.025" thickness, as shown in Figures 2-1D and 2-1E. A .25 inch wide channel was added to weaken the part.

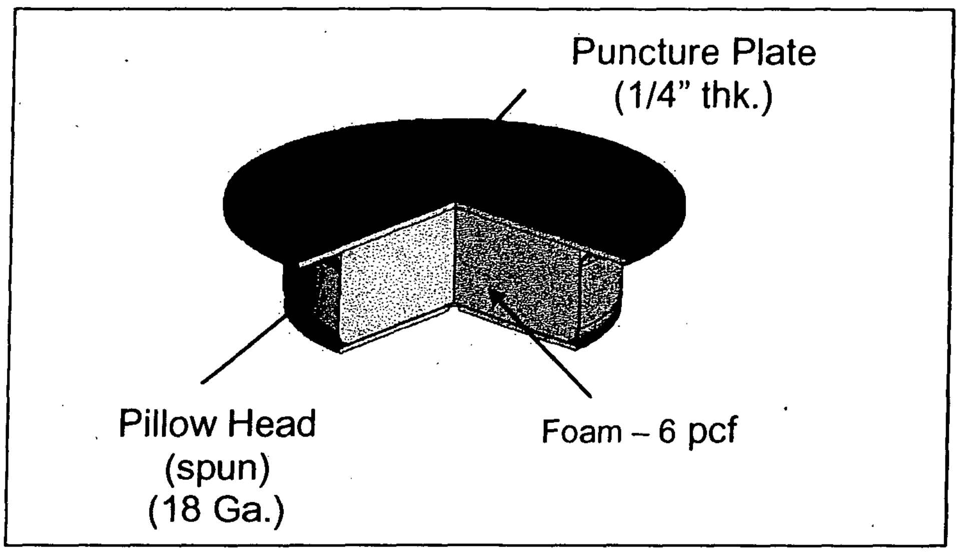

Figure 2-1B Impact Limiter "Pillow" Assembly

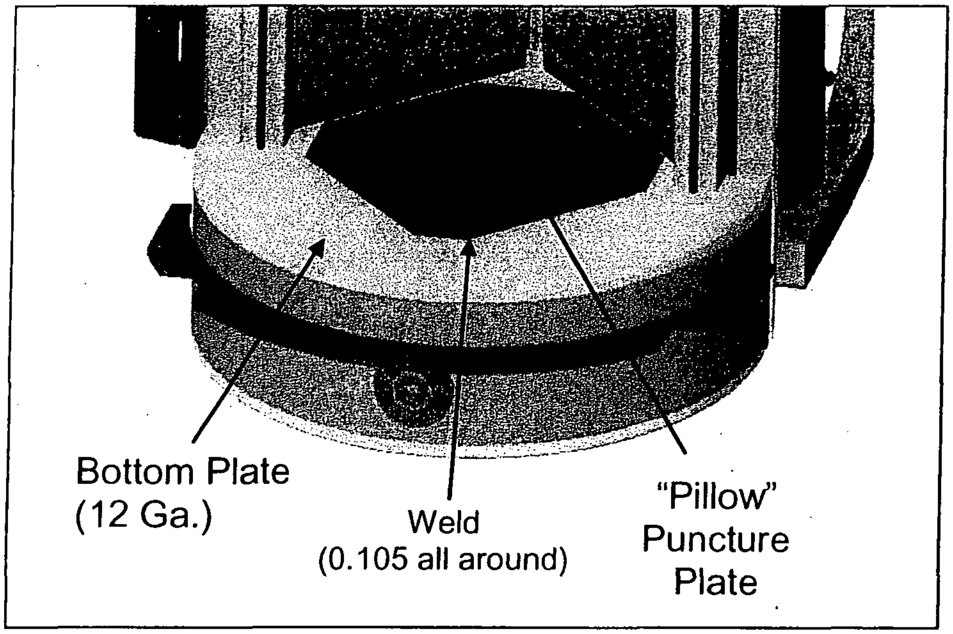

Figure 2-1C Container Bottom End

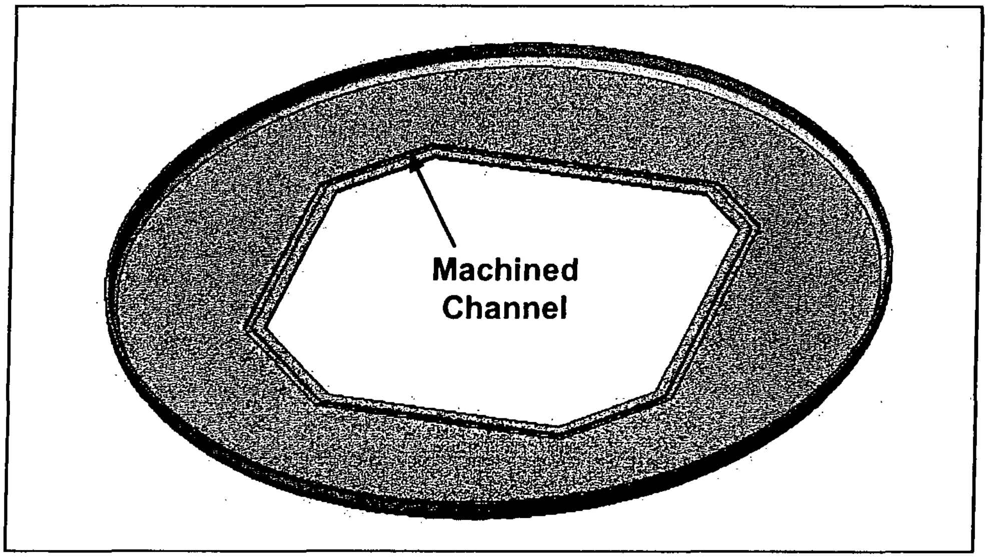

Figure 2-1D Bottom Plate (Viewed from Inside)

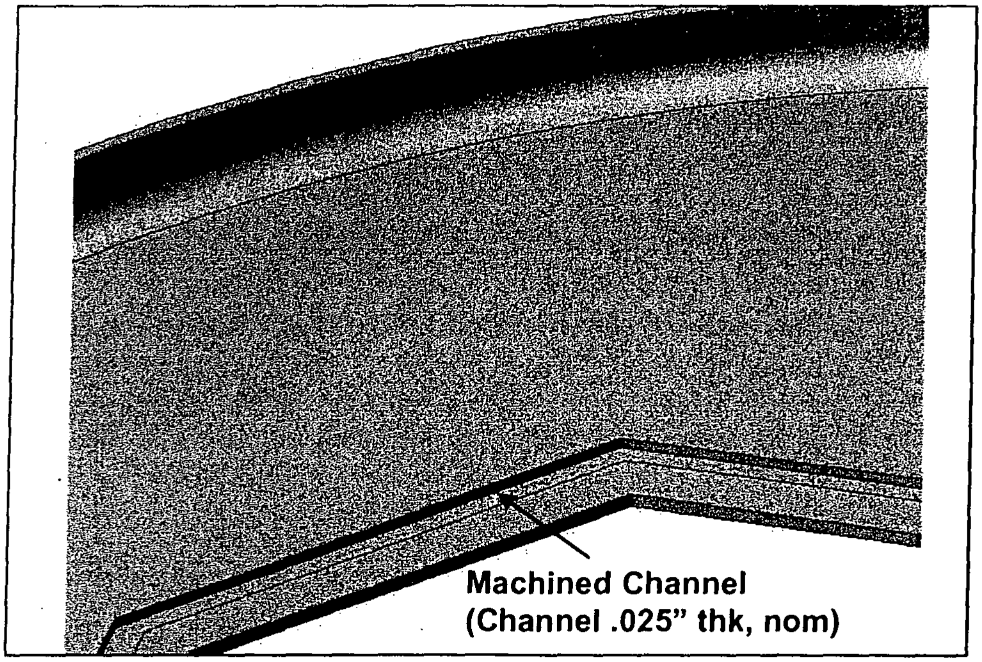

Figure 2-1E Bottom Plate – Viewed from Inside

The CTU design included a pinned connection (2 quick release pins – 0.5" diameter) between Outerpack halves at the bottom end of the package. Quick release pins were designed to help prevent the halves from warping and opening a gap locally during fire testing. Figure 2-1F shows the location of the quick release pins. During drop testing, the pins failed, therefore, they could not be used in the fire testing.

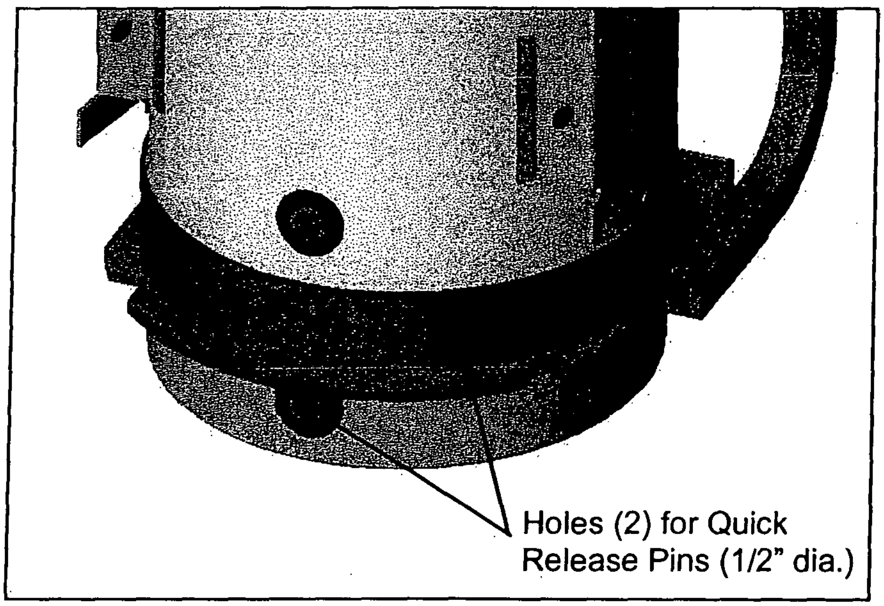

Figure 2-1F CTU Package Bottom End

2-6 Revise stress allowables, as appropriate in Table 2-8 for the structural entities other than lifting attachments and tie-down devices, , to ensure acceptable factors of safety against material yield strengths. Loadings on packaging components other than lifting attachments and tie-down devices are generally not factored up, as required by 10 CFR 71.45, by appropriate load multipliers. As such, contrary to those listed allowable yield stresses, only fractions of material yield strengths can be counted on in a working stress evaluation of structural performance margins.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.45.

Westinghouse Response:

The following text has been added to Section 2.12.2.1:

The results of the design calculations (where applicable), acceptance criteria, and conditional acceptance are shown in Table 2-8. Based on the results in Table 2-8, the Traveller package is shown to be compliant to mechanical requirements described in 10 CFR 71 and TS-R-1. Where the design features of the Traveller eliminate design concerns (i.e., package tie-downs, internal pressure, etc.) detained stress calculations were not performed.

Table 2-8 has been revised.

2-7 Provide drawing details for the swing bolt block, as identified in Figure 2-9, used for the alternative lifting configuration. The swing bolt block depicted in Figure 2-9 lacks sufficient detail to enable proper evaluation of its structural capacity.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.35.

2-8 Clarify the apparent discrepancy of polyurethane foam densities between those stated in Section 2.12.2.2.4, "[t]he material of construction of the Traveller Outerpack include...and low density, closed cell polyurethane impact limiter/thermal insulator (10 pcf along the axis as well as 7 and 20 pcf at the end caps)," and those stated in Items 24 and 57, Drawing No. 10004E58, which specify the 20 pcf polyurethane foam for the end caps.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

2-9 Provide drawing details for the polyethylene panels installation plan, including dimensions of individual panels and location of bolting studs, to ensure that thermally induced interference stresses or gap expansions are within acceptable limits. The discussion on Differential Thermal Expansion, page 2-56, lacks sufficient design details for evaluating effects of differential thermal expansion on the structural performance of the polyethylene moderator panels which are important to criticality safety.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.33.

Westinghouse Response:

The following text has been added to Section 2.12.2.2.4:

The polyethylene moderator blocks are attached by 0.375 inch diameter weld studs on the inner skin of the on the Outerpack. The weld studs penetrate the moderator blocks through 0.563 inch diameter holes). The blocks are mounted with a nominal gap, block to block, of 0.260 inches. The coefficients of thermal expansions are:

- 304 stainless steel 9.6 μ in/in-F
- UHMW polyethylene 72 – 111 μ in/in-F

Using the worst difference in expansion coefficients, 100 μ in/in-F, the gaps between the blocks will accommodate heat up from 70° to 167°F. In addition, there is an additional 0.094 inch of clearance between the weld studs and each side of the holes in the polyethylene that will allow blocks with less than nominal clearance to slide in a direction to provide uniform clearance along the length of the Traveller.

Because the polyethylene's coefficient of expansion is much greater than stainless steel, interference between moderator blocks is not an issue when temperature drops. Instead, it is the interference between the blocks and the weld studs. Based on nominal clearances and a maximum distance of 17.0 inches from outboard hole-to-outboard hole, the package temperature can drop from 70°F to -41°F before the polyethylene is stressed. Most of the moderator blocks have significantly smaller distances between the outboard holes (6.5 to 12.5 inches) allowing them to accommodate larger temperature changes.

See Licensing drawings for additional details.

2-10 Revise Section 2.12.3, to include illustrations in sufficient detail for the finite element analysis (FEA) models of individual package parts and their interfaces. Also, revise the application to include descriptions of modeling parameters, such as element types, material types and associated state equations, and boundary conditions from which the calculated drop accident responses can be properly evaluated.

The color "solid model" representations of the package parts have not lent themselves to sufficient description of modeling parameters.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.73.

2-11 Provide a description of the attributes of and corresponding assumptions for the finite element models for the lipped/grooved interfaces between the Clamshell end plates themselves, at the top end, and between the Clamshell doors and the plate at the bottom end. The application (pages 2-75, 2-84, 2-96) notes that the Clamshell cross-sectional shape is predicted to stay essentially unchanged during the horizontal drops. Because the predicted deformation of the interlocked end joints will depend primarily on the assumptions made for the finite element model, sufficient modeling details, including gap size, and contact stiffness, if any, must be presented for evaluating the analysis results.

This information is being requested in accordance with the provisions of 10 CFR 71.33 which requires an application to include a description in sufficient detail to identify the package accurately and provide sufficient basis for evaluation of the package.

2-12 Provide a discussion, with respect to Figure 2-47, explaining the process of implementing a puncture drop analysis with the puncture pin hitting the Outerpack top that was damaged in a previous finite element simulation analysis of an angled drop onto the top nozzle end of the package.

It is not clear from the information provided how the damaged and, thus, deformed packaging finite element model from the drop test was reinitiated in a follow-up puncture drop analysis. 10 CFR 71.73(c)(3) requires that the puncture test be performed on the specimen that has undergone free drop tests, in a position to cause maximum damage to the package.

2-13 Provide a discussion clarifying the apparent discrepancy between the statement on page 2-98, "...the fuel rod and associated fuel assembly structures, except for the top and bottom nozzles, were converted into a rigid part...[t]his prevented the fuel rods from buckling...," and Figure 2-83 where fuel rods are shown buckled. It is not clear from the information provided how the rigid fuel assembly were modeled to allow fuel rod to buckle, which is only characteristic of the deformable fuel rods.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.35.

2-14 Correct the following apparent underscored typographical errors, as appropriate:

- Page 2-99, third line from the bottom of the page: "Figure 2-<u>50</u>"
- Page 2-103, fourth line from the top of the page: "Figure 2-<u>41</u>"
- Page 2-104, twelfth line from the bottom of the page: "Figure 2-<u>64</u>"
- Page 2-104,. ninth line from the bottom of the page: "Figure 2-<u>82</u>"
- Page 2-104,. third line from the bottom of the page: "Figure 2-<u>83</u>"
- Page 2-106, third line from the top of the page: "Figure 2-<u>44</u>"
- Page 2-159, Table 2-32, Item 2.1: "1.2-m <u>NAC</u> drop"
- Page 2-177, Figure 2-135: "Test <u>2.3</u>"
- Page 2-177, Figure 2-135: "Test <u>2.4</u>"

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

<u>Westinghouse Response</u>:

The following typographical errors have been corrected:

- Page 2-99, third line from the bottom of the page: "Figure 2-<u>49</u>"
- Page 2-103, fourth line from the top of the page: "Figure 2-<u>61</u>"
- Page 2-104, twelfth line from the bottom of the page: "Figure 2-<u>44</u>"
- Page 2-104,. ninth line from the bottom of the page: "Figure 2-<u>62</u>"
- Page 2-104,. third line from the bottom of the page: "Figure 2-<u>63</u>"
- Page 2-106, third line from the top of the page: "Figure 2-<u>64</u>"
- Page 2-159, Table 2-32, Item 2.1: "1.2-m <u>NAC</u> drop" (No correction needed) (Added reference for Table 2-32 to page 2-158)
- Page 2-177, Figure 2-135: "Test <u>2.3</u>" (Replaced Figure 2-135)
- Page 2-177, Figure 2-135: "Test <u>2.4</u>" (Replaced Figure 2-135)

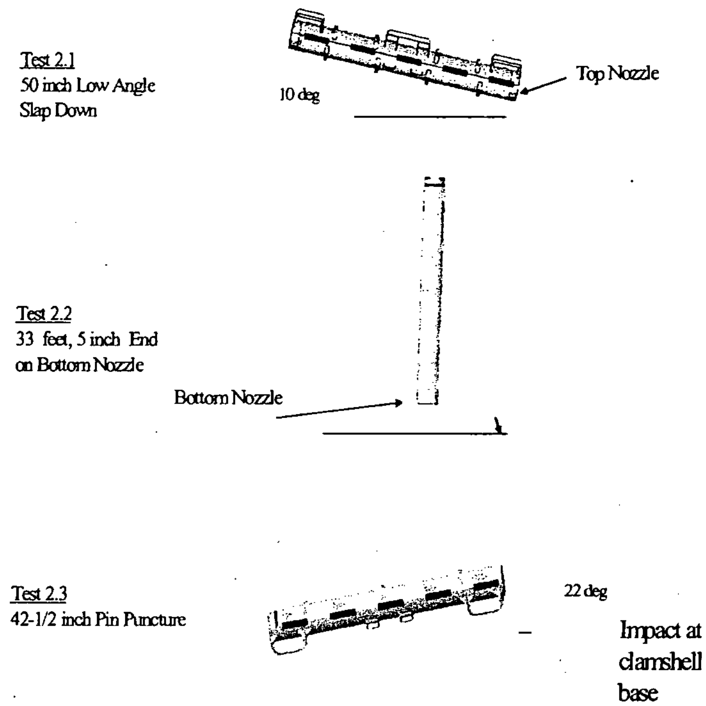

Figure 2-135 QTU Test Series 2 Drop Orientations

2-15 Provide a description of relevant model attributes, including use of sketches, to clarify the statement made on page 2-102, "[t]he vertical load developed by shock mounts is negligible and was ignored." It is not clear from the information provided how the Clamshell loads and accelerations are defined with respect to the Clamshell shock mounts layout.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.35.

2-16 Revise Section 2.12.3.2.6 to include a reevaluation of effects of temperature and foam density change on the drop test performance of the Traveller package, considering a 9-meter bottom-end down drop test.

The application evaluated temperature and foam density effects on structrual package performance by considering the 9-meter CG-forward-of-corner drops onto the top nozzle end of the package. The staff notes that this drop orientation with an initial point contact with the ground is much less stiff and, therefore, less sensitive to the foam density variation, than the flat bottom-end down drop where the impact footprint covers an entire end plate of the Outerpack. The present evaluation has not been shown applicable to the most damaging bottom-end down drop test for the temperature of -29°C (-20°F) in accordance with the requirements of 10 CFR 71.73(b).

2-17 Verify annotation for the measured "Y - Axial g-force" for Figures 2-89 and 2-119. Annotations for the drop response traces are confusing. Throughout the application, the Y coordinate appears to have been assigned to "Vertical," in lieu of "Axial," responses such as that of "Y - Vertical g-force" of Figure 2-118.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

2-18 Provide sketches depicting the accelerometer installation plan for the drop tests. The application should include accelerometer locations on the test articles to evaluate correlation between the measured and predicted results.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

<u>Westinghouse Response</u>:

The following text and Figure 2-117A have been added to Section 2.12.4:

The locations of these accelerometers are shown in Figure 2-117A.

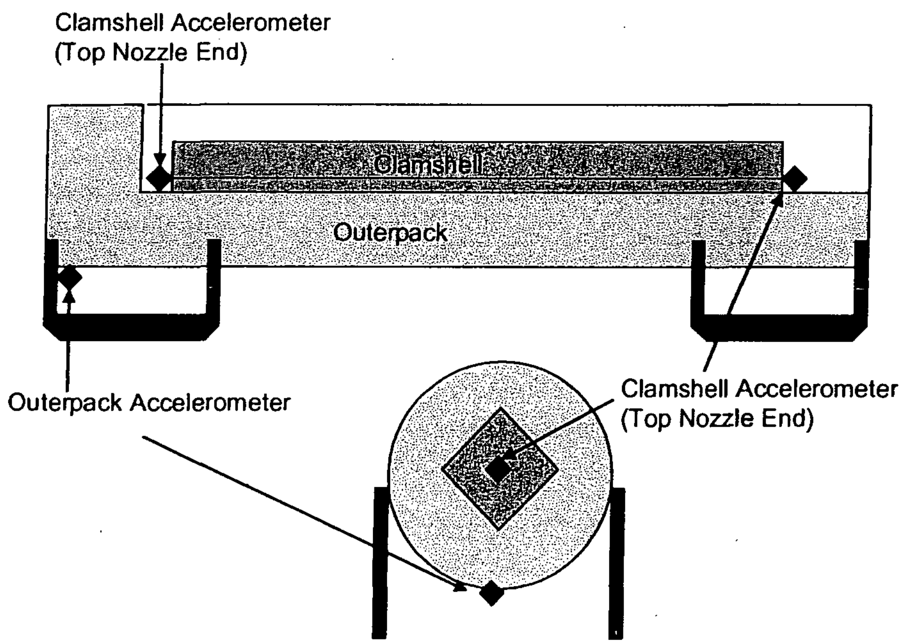

Figure 2-117A Accelerometer Locations on Prototype Drop Test

2-19 Provide a discussion addressing the sources for the discrepancy in weights in statements on pages 2-130 and 2-133:

Predicted model weight for the Prototype units was 2.39 tonnes (5258 lbs). This matched the Prototype unit's 5065 lb. average weight within 3.8%.

Predicted model weight was 2.27 tonnes (4994 lbs). This matched the qualification unit's 4786 lb. average weight within 4.4%.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

Westinghouse Response:

The following text has been added to Section 2.12.3.5.2:

Predicted model weight for the Qualification units was 2.27 tonnes (4994 lbs). This matched the Qualification unit's 4786 lb. average weight within 4.4%.

The Traveller program performed drop tests as input into the design process. As a result, there were changes in the design of the Traveller between the prototypes discussed on page 2-130 and the qualification test units described on page 2-133. The changes resulted in slightly different weights as noted in the descriptions.

2-20 Verify that appropriate finite element Clamshell models were used in the analysis of the Qualification Unit drop test. The staff notes that modeling attributes, including element meshes, are markedly different for the same Qualification Unit Model shown in the two plots, Figures 2-96 and 2-102. It is not clear from the information provided which Clamshell model was used in the analysis.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

2-21 Verify the temperature-dependence stress-strain curve plots, Figure 2-108, for the Clamshell aluminum at 160° F and -40° F. The stress-strain curves at the two temperatures appear to have been mislabeled.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

Westinghouse Response:

The following figure, Figure 2-108 has been replaced:

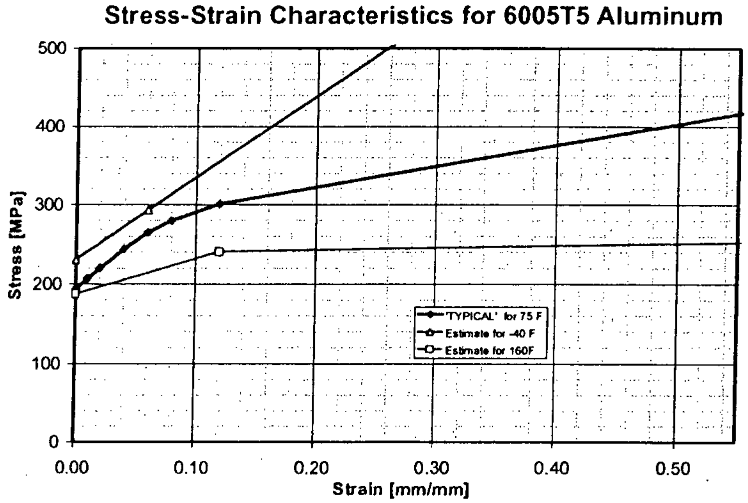

Figure 2-108 Stress-Strain Characteristics of Aluminum in Clamshell

2-22 Revise Figure 2-105, as appropriate, to provide detailed stress-strain data for the strains ranging from zero to ten percent. Also, re-evaluate the bottom end drop to determine effects of cold temperature on package structural performance by using relevant stress-strain data in the finite element analysis. The staff notes that there are no stress-strain data reported for the strain range cited above. By assigning a yield point at the 10-percent strain offset, which had not been substantiated, the result was an assumption on the rate of momentum change of the free dropping package to dictate certain analysis outcomes.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

2-23 Provide a description of the finite element models used for calculating bolt axial and shear forces, Table 2-26. For the resulting forces, justify the basis for using the ultimate strengths in the interaction equation evaluation of factors of safety for the bolts subject to concurrent tensile and bi-axial shear forces. It is not clear from the information provided whether the bolts were allowed to yield in the finite element analysis of the drop accident, which could markedly affect the calculated bolt forces. The staff notes that bolt interaction equations generally do not lend themselves to an evaluation involving material ultimate strengths.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

2-24 Verify that Table M-2 is a correct reference as cited in Note 2 of Table 2-26. Table M-2 is not included as part of the application.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

2-25 Provide a discussion clarifying the apparent discrepancy between the statement provided on page 2-148, "[t]he prototype packages employed 11 pcf foam along the axial section of the package and 16 pcf foam in the endcaps," and the information provided in Figures 2-95 and 2-112 which indicate that the end cap for the Prototype Test Unit was filled with the 11 pcf, rather than the 16 pcf, foam.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

<u>Westinghouse Response</u>:

The following figure, Figure 2-95, has been replaced:

Impact Limiters in Prototype Unit Model

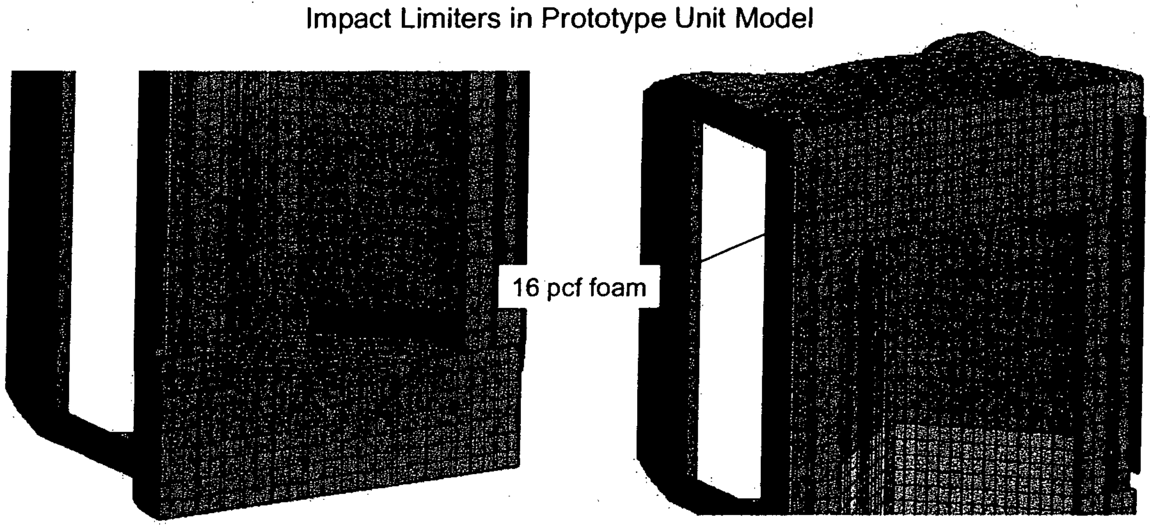

Figure 2-95 Impact Limiter in Prototype Unit Model

2-26 Provide a capabilities summary of the analytical models developed and benchmarked for the package drop analysis, including a discussion, as an example, of why the connector bolts for both the top and bottom Clamshell head pieces were not predicted by the finite element analysis but were observed to shear-out during the bottom nozzle 9-meter CG-over-the-corner drop tests, for analytical modeling of the packaging. It is not clear from the information provided whether the reported damages, such as those that appear to be associated with the bottom nozzle end drop, were predictable with the finite element analysis. Limitations of the finite element analysis models in predicting structural damages, such as those exhibited in Figures 2-115 and 2 -117, should also be clearly delineated to facilitate safety review.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

2-27 Provide a discussion explaining the apparent discrepancy between the measured vertical decelerations of 191 g in Table 2-30 and 205 g in Figure 2-91.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

<u>Westinghouse Response</u>:

The following figure, Figure 2-91, has been replaced:

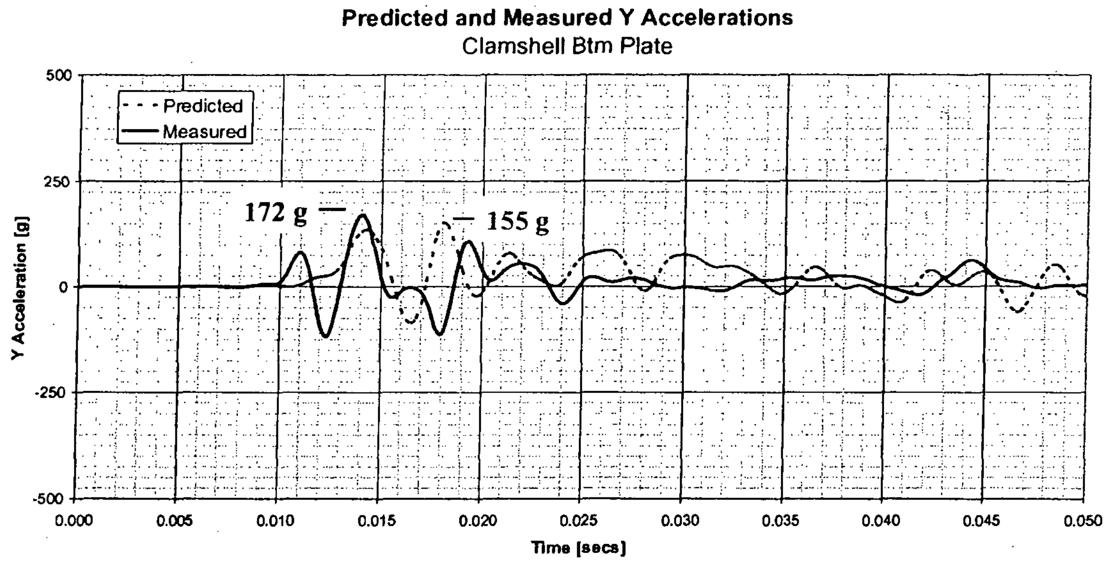

Figure 2-91 Predicted and Measured Y Accelerations

2-28 Provide a discussion clarifying the drop angle/orientation depictions of Test 1.2 and Test 1.3 in Figure 2-129 for the respective CG-Over-Corner and pin puncture tests. It is not clear how the drop angle of 108° was defined for Test 1.2. The puncture drop of Test 1.3 does not appear to have the package hinge side of the Outerpack land on the puncture pin as described in the text.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

Westinghouse Response:

The following text has been added to Section 2.12.4.2.1 and Figure 2-129 has been replaced:

A pitch angle of 72 degrees was measured along the outerpack surface for Test 1.2. The angle of 108 degrees should be located as shown in Figure 2-129. The reference to "hinge side" in Test 1.3 indicates the package side that pivots, rather than the actual hinge. The impact point of Test 1.3 (Figure 2-132) was on the top nozzle end and on the pivot (left) side of the package.

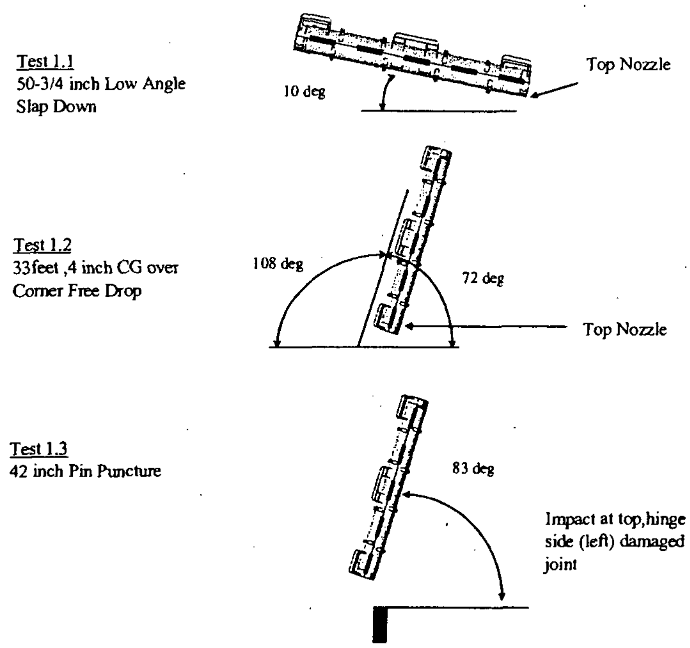

Figure 2-129 Drop Orientation for QTU Test Series 1

2-29 Revise the SAR to include a drop test evaluation of the package transporting the loose rods in a rod box or rod container.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.31(a)(2).

Westinghouse Response:

The following text has been added as a new section – Section 2.11.1:

2.11.1 Rod Box

The Traveller Clamshell is designed to accommodate PWR fuel assemblies. To accommodate loose fuel rods, two rod storage containers have been examined. One, is a 304 stainless steel rod pipe with a maximum diameter of 6.625 inches (6" Schedule 40 pipe), length of 168 inches, and a total weight of 635 lbs (loaded). The second option is a 304 stainless steel box width with a 5.12 inches cross-section. This box is 170.5 inches long and weighs 660 lbs loaded. Other optional designs are being examined which would reduce total length to 169 inches to allow use with the Traveller STD package.

The rod pipe and rod box are both designed to be contained within the Clamshell and restrained axially and radially. Although the rod box has a smaller wall thickness than the tube (0.059 vs 0.280 inches), both are substantially stiffer than the PWR fuel assemblies that the Clamshells normally carry. This, combined with the substantially lower weight of the loaded rod pipes or boxes (660 lb for the rod box vs. 1753 lbs for the fuel assembly used in the drop testing described) make accident scenarios with the rod pipe or rod box less challenging. The rod pipe or box, reinforce the Clamshell to prevent change in fuel geometry. The lower weight, reduces loads on Clamshell and Outerpack. The lower fuel load, reduces criticality concerns. It was therefore concluded that the Traveller package with a rod pipe or rod box is bounded by the CTU tests described

Request for Additional Information
Model No. Traveller
Docket No. 71-9297

By application dated April 1, 2004, Westinghouse Electric Company requested a Certificate of Compliance for the Model No. Traveller package. This request identifies additional information needed by the Nuclear Regulatory Commission staff (the staff) in connection with its review of the safety analysis report (SAR). The requested information is listed by chapter number and title in the SAR. NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material," was used for this review. This request describes information needed by the staff for it to complete its review of the SAR and to determine whether the applicant has demonstrated compliance with regulatory requirements.

Chapter 3 Thermal Evaluation

3-1 Revise the SAR to specify the orientation of the certified test unit (CTU) with regard to the fire test pool. Specifically, state the distance the bottom of the package was positioned above the fire pool surface and the distance the pool extended beyond the ends of the package.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.73.

<u>Westinghouse Response</u>:

The following text and figure have been added to Section 3.6.4:

Figure 3-27A shows the orientation of the Certification Test Unit (CTU) for the thermal test. The bottom of the package was positioned approximately 1 meter from the top of the fire pool surface. The distance of the outer facility walls beyond the edge of the package were 67" at the ends and 71.5" at the sides.

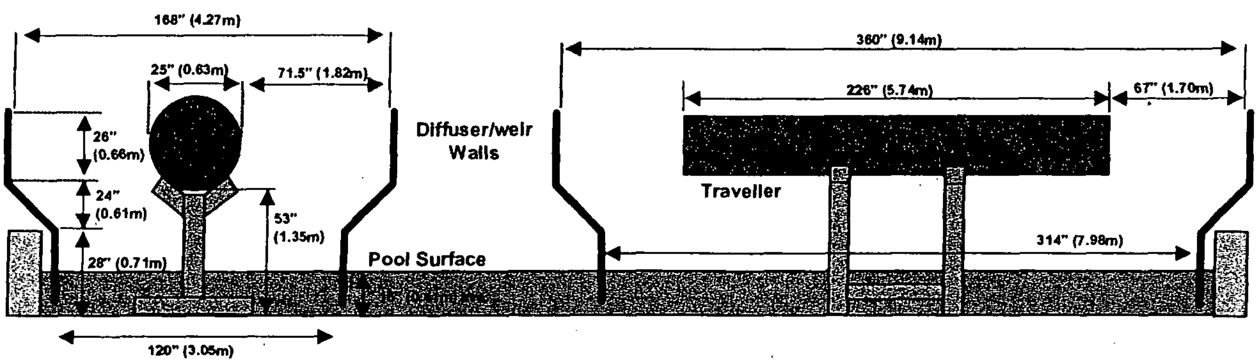

Figure 3-27A Orientation of CTU for Thermal Test

3-2 Revise Section 3.6.4 of the SAR to explain why the 30 minute average flame temperature of 859 ^{0}C and the temperature of 833 ^{0}C measured from the directional flame thermometers (DFTs), is lower than the 904 ^{0}C package skin temperature for the fire test of the CTU.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.73.

Westinghouse Response:

The following text and Table 3-4A have been added to Section 3.6.4.1:

Twenty-two (22) thermocouples were used to measure external conditions on and around the Traveller package during the February 10, 2004 fire test. These sensors were located as shown in Figure 3-30 in the SAR. Due to the natural instability of open flames, combined with wind effects, these thermocouples were periodically uncovered. As shown in Figures 3-38 through 3-43, this resulted in large variations in measured temperature. These variations are largest at the corners of the pool fire where small disruptions in the flame would change air temperature at the thermocouple location. These disruptions were the smallest at the package skin because it was in the center of the pool fire.

Table 3-4A below, summarizes the thermocouple data for the test. Some of the thermocouples had average temperatures under 800°C but all experienced temperatures above 900°C during the test, demonstrating that the fire covered the complete pool area. Some of the minimum temperatures recorded are due to the time selected for the 30 minute average. A fire this size cannot start instantaneously, nor did it end instantaneously. As a result, the 30 minute period selected for averaging data includes data when some TC were beginning to heat up and when some were already cooling off after the fire. The data still shows that the average skin temperature, the average DFT temperature and the average temperature of TCs in the flame were all above 800°C for the 30 minute period selected.

Table 3-4A Summary of Recorded Temperatures During Burn Test

TC Location	30 Minute Ave (°C)	Max Temp (°C)	Min Temp (°C)
NE Lower Flame	727	959	275
NE Upper Flame	925	1245	493
E Lower Flame	926	1155	489
E Upper Flame	904	1163	532
SE Lower Flame	714	962	291
SE Upper Flame	924	1245	484
NW Lower Flame	630	906	329
NW Upper Flame	748	1059	458
W Lower Flame	997	1162	640
W Upper Flame	1027	1173	661
SW Lower Flame	827	1032	230
SW Upper Flame	1000	1213	598
NE DFT	804	907	454

Table 3-4A Summary of Recorded Temperatures During Burn Test			
TC Location	30 Minute Ave (°C)	Max Temp (°C)	Min Temp (°C)
SE DFT	801	964	338
NW DFT	854	1016	541
SW DFT	876	1003	594
NE Skin	878	1058	610
E Skin	917	1073	699
SE Skin	903	1088	542
NW Skin	725	990	492
W Skin	974	1080	682
SW Skin	1028	1143	719

Because the thermocouples in the corners of the pool were not engulfed as long as the package itself, the 30 minute average temperature for the corners is lower than in the center of the pool. The total average for all of the thermocouples in the flame was 862°C versus 812°C for the corner thermocouples in the flame. The DFT average readings are also lower for similar reasons. The DFTs insulated the thermocouple and attached face plate from convective heat transfer. Radiative heat transfer was dominate by design. Because these devices faced away from the package, they recorded equilibrium temperature based on radiation from the fire and reradiation to cold surfaces outside the fire, without contribution from convection. The skin temperature is an equilibrium temperature that includes convective heat transfer from hot combustion gasses. As a result, its temperatures should be higher.

As described in the discussion of thermal analysis results (section 3.6.1) the long length to diameter ratio of the Traveller package minimizes the role of axial heat transfer inside the package. Non-uniform external temperatures produce non-uniform internal temperatures during fire tests. This fundamental mechanism allowed useful data to be obtained in the seam burn and impact limiter burn tests described in sections 3.6.2 and 3.6.3. This mechanism was demonstrated by the very low clamshell temperatures measured adjacent to the heated sections in those tests. During the CTU burn test, the average skin temperature at the North end, middle and South end of the package was 801°, 946°, and 915°C respectively. Peak interior temperatures recorded by the non-reversible temperatures strips were 116°C at the North end of the package, 177°C at the middle of the package, and 143°C at the South end of the package. At the center of the package, where the average exterior skin temperature was 946°C, the corresponding interior temperatures were acceptable for all materials in the package.

3-3 Revise the SAR to explain why exceeding the melting temperature of the polyethylene is acceptable and provide documentation of its material properties at these temperatures. Additionally, provide justification as to how it was determined that the moderator maintained at least 90-percent of its hydrogen post fire.

Figure 3-45 in the SAR and related description indicate that the polyethylene moderator exceeds its melting temperature of 125-138 ^{0}C (see Table 3-2) at four of six locations measured. No justification is provided other than implicitly from an examination of the moderator after the fire where it is stated that the moderator had no significant damage.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.73.

<u>Westinghouse Response</u>:

The following text has been added to Section 3.6.4.1:

Ultra-high molecular weight (UHMW) polyethylene was selected as the neutron moderator for the Traveller package because of its high hydrogen content, its ductility at very low temperatures and its high viscosity at temperatures well above its melt point due to the long molecular chains (MW=3,000,000 to 6,000,000). The relative solution viscosity as measured by ASTM D4020 must be greater than 1.4[1] and is typically found to be 2.3 to 3.5 dl/gm[2] (at 135°C). As a result, UHMW polyethylene does not liquefy above its melt temperature and molded UHMW polyethylene parts are typically made at relatively high temperatures (190° – 200°C) and very high pressures (70-100 bar)[3]. Its excellent stability allows it to be used in some applications at temperatures as high as 450°C[4]. Experience in the Traveller test program has shown that the material will soften but not run, even when heated to near vaporization temperature (349°C). However, the Traveller design encapsulates the moderator with stainless steel. This is primarily done to prevent oxygen from reaching the moderator, should it reach vaporization temperature, but it does serve a secondary function of ensuring that the moderator does not significantly distort or flow at high temperatures.

The highest measured temperature inside the package was 171°C which is lower that the typical process temperature used to create the UHMW sheets installed in the Traveller. Unchanged appearance and more importantly, unchanged weight indicate that the plastic did not loose a significant amount of its hydrogen during the test.

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[1] Stein, H.L., "Ultra High Molecular Weight Polyethylene (UHMWPE)," Engineered Materials Handbook, Vol. 2, Engineering Plastics, 1998.

[2] This is a typical value observed in many manufacturers specifications: Crown Plastics (crownplastics.com/ properties.htm).

[3] Ticona Engineering Polymers information on compression molding, www.ticona.com/index/tech/processing/compression_molding/gur1.htm.

[4] Stein, H.L., "Ultra High Molecular Weight Polyethylene (UHMWPE)," Engineered Materials Handbook, Vol. 2, Engineering Plastics, 1998

3-4 Provide justification as to why the location of the temperature strips on the upper half of the outerpack would be representative or bounding of temperatures for the moderator in the lower half.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.73.

<u>Westinghouse Response</u>:

The following text has been added to Section 3.6.4.1:

Earlier analysis and tests had shown that, if there was no substantial infiltration of hot gas into the package, interior temperatures would remain low during the fire test. This is shown in the results of both the seam burn tests and the impact limiter burn tests (sections 3.6.2 and

3.6.3). In these tests, interior temperatures rose between 50° and 110°C during and after the test. These values are conservative because the tests were performed on a previously burned package where the polyurethane had already turned to char. The primary design concern was hot gas infiltration during the CTU burn test. This would add substantially more heat and cause higher temperatures. This was observed in an earlier burn test (QTU-1). This package was oriented in the same fashion as the CTU, with one Outerpack seam facing the pool surface. Distortion of the Outerpack walls caused hot gasses to enter the package and flow around the clamshell. Because of the geometric arrangement of the Outerpack seam lip, this flow was directed preferentially over the top of the clamshell (as oriented when the package is resting on its feet). Polyurethane ignited at four locations in this region and burned. The moderator under the clamshell was undamaged. Based on this evidence, it seemed best to concentrate the temperature indicating strips on the moderator surface that was expected to be the hottest if significant hot gas infiltration occurred.

3-5 Provide a picture and description in the SAR of the damaged Traveller package resulting from the regulatory drop before the fire test. Include an evaluation of this structural damage with regard to its impact on the fire results.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.73.

Westinghouse Response:

The following text has been added to Section 3.6.4:

(Please see section 2.12.4.2.3 in the Safety Analysis Report (pp 3-183 through 3-192) for description of the CTU drop tests and the resulting damage.)

3-6 Revise the SAR to include an evaluation of the sensitivity of the various temperature measuring instruments and explain the impact of this sensitivity analysis on the recorded fire temperature and the moderator temperature.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.73.

Westinghouse Response:

The following text has been added to Section 3.6.4:

The primary sensors used in the tests were Omega XCIB-K-4-12 thermocouples connected via approximately 50 ft of 20 gage type K, Teflon coated, extension wire. The type K thermocouples have standard limit of 4°F (2.2°C) or 0.75% between 32° and 2282°F (0° and 1250°C). The 20 gage chromega/alomega wire has a resistance of 0.586 ohms per double foot of length. Two types of data recorders were used. Two Omega OM-CP-OCTTEMP 8 channel data recorders were used for 14 channels of data. These recorders have a -270° to 1370°C temperature measurement range for Type K thermocouples and 0.5°C accuracy for type K thermocouples. The recorders were purchased new from Omega and were used within the time limit of their original factory calibration. Eight channels of data were recorded using a Instrunet, data acquisition system with an INET-100 external A/D box connected to a Toshiba Satellite notebook computer running Windows XP Professional using a INET-230 PC card controller. This system, with Type K thermocouples has an accuracy of ±0.6°C between -50°

and 1360°C. The lowest average temperatures from the CTU burn test were the DFT readings which had an 834°C, 30 minute average temperature. Adding the worst case thermocouple and data recorder errors results in a 6.8°C average error. This is not sufficient to lower average temperature below 800°C.

3-7 Revise the SAR to clarify the last sentence in Section 3.1.1 which states, "[t]he package survived the test with maximum internal temperatures less than 150 °C." This conflicts with the information provided on Figure 3-45 which shows moderator temperatures exceeding 150 °C.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

Westinghouse Response:

The following revision has been made to Section 3.1.1:

Changed "... internal temperatures less than 150°C." to "... internal temperatures less than 180°C."

3-8 Expand Table 3-1 of the SAR to include other significant Traveller package materials (*e.g.*, polyurethane foam, fibreglass seals, refractor insulation). Also, for conformity with the other materials listed in this table, the polyethylene moderator should include its melting point rather than ignition/boiling point with a footnote explaining its behavior and rational for its acceptance criteria.

This information is required in accordance with 10 CFR Part 71.33 which states that applications must include a description in sufficient detail to identify the package accurately and provide a sufficient basis for evaluation of the package.

Westinghouse Response:

The following information has been added to Table 3-1:

Fiberglass seals (Thermojecket S)	1000°F (long term)	Temperature not measured/Seals present after fire test
Refractory fiber felt insulation	2300°F (melt)	177[2]

The following information has been added to Table 3-2:

Fiberglass seals (Thermojecket S)	NA[2]	538°C[1] 1000°F	NA[2]	NA[2]
Refractory fiber felt insulation	0.097 g/cc .0035 lb/in^3	1260°C 2300°F	.06 W/m-K .034 BTU/hr-ft-F	1.0 J/g-°C 0.239 BTU/lb-°F
Notes: (1) Maximum use temperature for Federal Mogul Product with acrylic resin added to reduce fray. (2) Seal is used to minimize hot gas infiltration. It is not used as thermal insulation and, because of its				

low mass, its heat capacity is insignificant.

3-9 Provide a discussion reconciling the differences between the thermal analysis provided in Section 3.6.1, Traveller Thermal Analysis, and the fire test results. An alternative would be to delete Section 3.6.1 if this information is extraneous.

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

Westinghouse Response:

The following text has been added to Section 3.6.1:

The thermal analysis performed demonstrated several important features/characteristics of the design. Because of the urethane foam insulating the Outerpack, exterior skin temperatures quickly rise to near equilibrium with the fire outside the package. The clamshell and fuel assembly temperature, rise very slowly due to the insulation and the specific heat of the aluminum clamshell, polyethylene moderator, and the fuel assembly. The primary mechanisms that can result in significantly higher internal temperatures is hot gas infiltration during the fire and internal combustion during and after the fire test. We do not believe that these mechanisms can be accurately predicted by analysis. As a result, the Traveller team chose to demonstrate the package using pool fire tests, culminating with a full-scale fire test.

The seam burn tests with continuous hinge sections demonstrated approximately 60°C temperature rise during and after the test which was in close agreement with the 50°C temperature rise predicted by the analysis. The CTU burn test demonstrated internal temperatures between 116° and 177°C. This is 112° to 173°C higher than the air temperature that morning. These values are only 66° to 127°C higher than the equilibrium package temperatures maintained by heaters before the fire. As noted above, the external skin temperature at the middle of the package was significantly higher at the middle. Secondly, the amount of hot gas entering the package at different locations along the length clearly affects the local internal temperatures. Greater quantities of hot gas probably entered that package at that location.

Because of the fundamental limitations of the analysis (e.g., inability to predict precise geometry changes during the fire) the analysis model was never refined and exact agreement was never anticipated with test results. The analysis does illustrate the fundamental mechanisms involved and the general characteristics of the package response, assuming no significant gas infiltration or geometry changes.

3-10 Revise the SAR to clearly state that the package after the fire test was allowed to burn until it naturally extinguished. Also, include a discussion why none of the means used to extinguish the pool fire had any adverse impact on allowing the package to burn as long as it naturally could.

Section 3.6.4, the first sentence of the forth paragraph, states, "[a]fter the pool fire was extinguished, the package was removed from the pool and allowed to cool." While Section 3.6.4.1, the last two sentences of the second paragraph states, "...although burning polyurethane from the package reignited residual fuel at one end of the pool shortly afterwards. This was extinguished using the fire suppression system. Both statements are opened ended with regard to the package being allowed to burn until naturally extinguished.

This information is being requested to enable the staff to determine compliance with the requirements of 10 CFR 71.73.

Westinghouse Response:

The following text and Figures 3-27B and 3-27C have been added to Section 3.6.4:

The fire test facility was originally designed to terminate the fire test by shutting off fuel flow and allowing the fuel at the surface of the pool to burn off. Testing revealed that, in some circumstances, excess fuel could buildup on the pool surface causing the fire to continue burning for five minutes or longer. As a result, a simple fire suppression system was added to the facility. A water hose was connected to a nearby fire hydrant, Figure 3-27B. This hose utilized a suction line to siphon standard fire suppressant foam into the line, Figure 3-27C. The hose discharged into a single pipe that fed into the pool a few inches above the water level. When activated, the system would inject foam horizontally onto the surface of the pool, well below the test article. When used in combination with the fuel shutoff valves, the pool fire was extinguished within 60 seconds. This system did not cool the test article when in use and the package was allowed to naturally extinguish itself after the test. This was demonstrated by the CTU burn test, where the polyurethane at the Outerpack vent ports continued to burn many minutes after the fire suppressant was used on the pool surface.

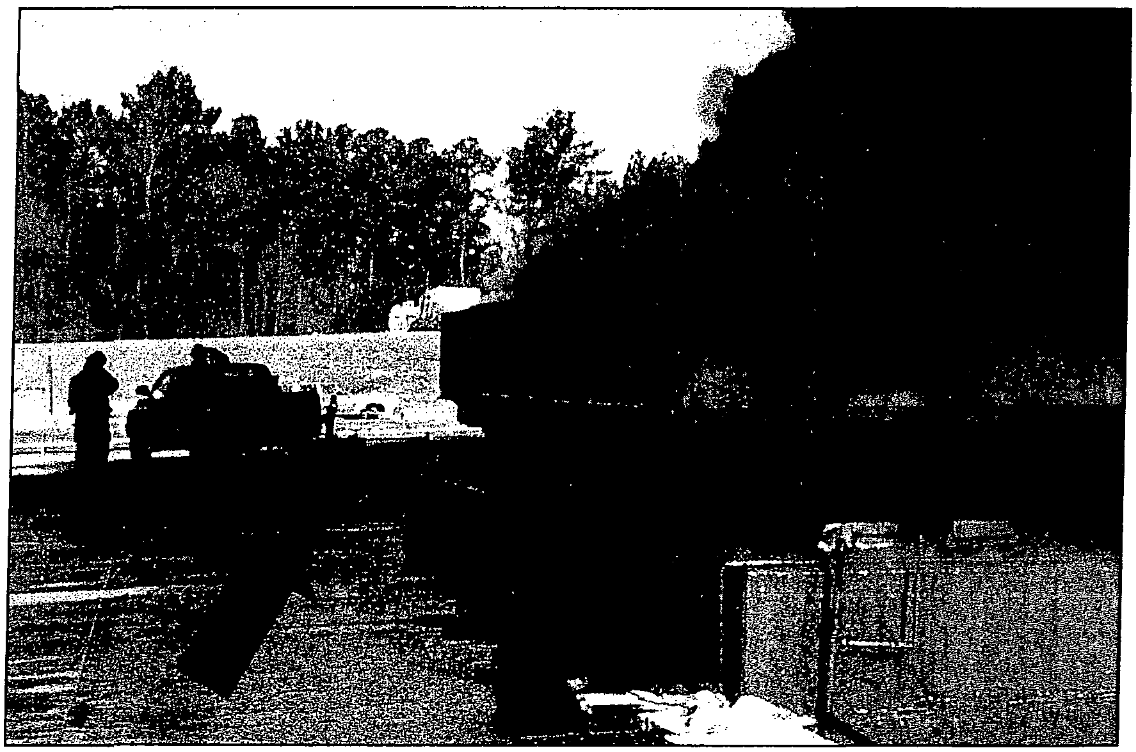

Figure 3-27B Fire Fighters Standing by Fire Suppression System

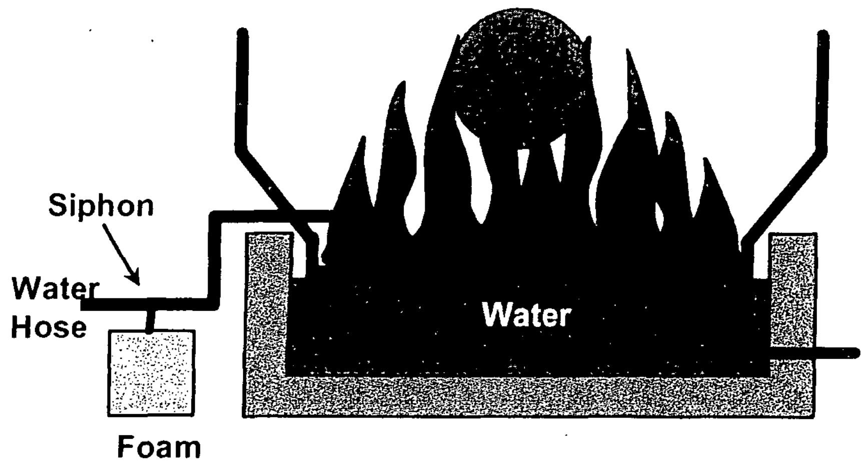

Figure 3-27C Approach to Suppress Pool Fire at End of Test

3-11 Editorial: Correct typographical error in Section 3.6.3 of the SAR, the fifth line should read: "... pillow is separately encased..."

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

Westinghouse Response:

Corrected typographical error in Section 3.6.3 of the SAR, the fifth line now reads: "... pillow is separately encased..."

3-12 Editorial: Correct inconsistency in terminology. Page 3-26, mentions "refractor insulation" and Page 3-46, mentions "refractory felt."

This information is required in accordance with 10 CFR Part 71.7(a), which states that all information provided to the NRC by an applicant must be complete and accurate in all material respects.

Westinghouse Response:

The term "refractory fiber felt insulation" is used in all places.

Request for Additional Information
Model No. Traveller
Docket No. 71-9297

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Chapter 7 Operating Procedures

7-1 Provide clarification as to what the statement in Section 7.1.1.2 "[M]ove the package into for water leaks" means.

This information is being requested to enable the staff to determine compliance with 10 CFR 71.81.

Westinghouse Response:

Change Section 7.1.1.2 to read as follows:

7.1.1.2 Clean Shipping Package

- Use soap or a suitable detergent and water to clean the package.
- Hose down the package and direct a high pressure water stream.
- Move the package into the refurbishing area to check for water leaks.

7-2 Provide clarification as to the maximum number of "fuel assemblies and core components" that are to be transported in a single Traveller transport package, Section 7.1.2.1.

This information is being requested to enable the staff to determine compliance with 10 CFR 71.81.

Westinghouse Response:

Change Section 7.1.2.1 to read as follows:

7.1.2.1 Inspection

- Verify that the fuel assembly and core component have been released and the proper component is being shipped with the assembly.
- Verify that the fuel assembly is properly oriented in the package.
- Verify the number of shock mounts is correct and accelerometers are sealed, calibrated and not tripped.

- Verify general cleanliness and absence of debris on package internals, fuel assembly, package shell lower subassembly prior to closing the package.
- Verify placement and integrity of shipping package gasket.

7-3 Revise Section 7.2.1 to include a statement of what action is to be taken if a security seal is missing.

This information is being requested to enable the staff to determine compliance with 10 CFR 71.81.

Westinghouse Response:

Change Section 7.2.1 to read as follows:

7.2.1 Receipt of Package from Carrier

- Perform an external inspection of the unopened package and record any significant observations.
- Verify that two tamper proof security seals have been properly placed on each package. If either seal is missing or damaged, record the damage and follow site procedures for possible security issues.

7-4 Revise Section 7.3 to either include the "prescribed limits" or a reference to where these "prescribed limits" can be found.

This information is being requested to enable the staff to determine compliance with 10 CFR 71.81.

Westinghouse Response:

Change Section 7.3 to read as follows:

7.3 PREPARATION OF EMPTY PACKAGE FOR TRANSPORT

- Verify the package is empty of contents.
- Verify radiation levels do not exceed limits prescribed in 49 CFR 173.421 (a) (2).
- Verify non-fixed radioactive surface contamination does exceed limits prescribed in 49 CFR 173.421 (a) (3).
- Verify the package does not contain more than 15 grams of uranium-235.
- Verify the packaging is in unimpaired condition and is securely closed.
- Verify the internal contamination does not exceed 100 times limits prescribed in 49 CFR 173.428 (c).
- Remove any previously applied labels affixed for fuel shipments.
- Affix an "Empty" label.