71-9297

Westinghouse

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

Attn: Document Control Desk
Director, Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Direct tel: (803) 647-3167
Direct fax: (803) 695-4164
e-mail: vescovpj@westinghouse.com

Our ref: UAM-NRC-06-011
Your Ref: Docket No. 71-9297
TAC No. 123915

September 26, 2006

SUBJECT: CERTIFICATE OF COMPLIANCE NO. 9297 FOR THE MODEL NO. TRAVELLER PACKAGE: Submission of Revision 6 to the Safety Analysis Report (SAR)

Dear Mr. E. William Brach:

An application request is attached for the Certificate of Compliance No. 9297, Model Traveller shipping package. This request includes information about packaging components used to secure the contents and revision to the Application for Certificate of Compliance to describe the new packaging components.

The 14X14 CE-1/CE-2, 16X16 CE, ATOM 16X16, and ATOM 18X18 fuel assembly types are authorized contents for the Traveller. The CE fuel assembly types are currently transported in the Model No. 927A1 and 927C1 shipping packages as authorized in Certificate of Compliance No. 6078. The expiration date for CoC No. 6078 is October 1, 2008, and this certificate is not renewable. The ATOM fuel assembly types are transported in the Model ABB ATOM package authorized by foreign approvals for transport container certificate D/4350/IF-96, and the expiration date is January 31, 2007, for this certificate. A packaging component used to secure these non-Westinghouse fuel assembly types in the Traveller was designed after approval of the Traveller. Non-Westinghouse fuel assembly type shipments using the Traveller are planned for domestic and foreign customers. Westinghouse plans to start using the Traveller to transport 16X16 CE fuel assembly type to a U.S. customer in January 2007.

Engineering drawing(s) for package approval will be modified to add details for the new packaging component. A copy of the engineering drawing marked for revision is submitted with this request. The engineering drawing is in approval routing and drafting and the approved drawing will be submitted in an addendum to this request. Section 1 of the Application for Certificate of Compliance is also revised to describe the new packaging component.

Please direct any questions to Peter Vescovi at (803) 647-3167.

NMSS01

Sincerely,

Peter J. Vescovi
WESTINGHOUSE ELECTRIC COMPANY, LLC
Uranium Asset Management, Regulatory and International Logistics
Transport Licensing and Compliance

Enclosures

1. Description and Justification of Proposed Changes
2. Proposed wording for Certificate of Compliance USA/9239/AF-96
3. Pages affected in License Application
4. Previous Versions of Certificate of Compliance USA/9239/AF-96 including NRC SER

uam-nrc-06-011-traveller sar rev 6.doc

By Federal Express

Enclosure 1 - Description and Justification of Proposed Changes

Background

Impact orientations that would result in the most damage to fuel assembly contents and packaging were considered in order to determine the worst case package orientation for transport accident condition testing. Based on analyses and testing, it was determined that the most severe impact for the fuel assembly contents and packaging is the 9 m impact in a bottom-end down orientation due to the resulting fuel rearrangement, that is lattice expansion, and damage that would be most severe for packaging performance during thermal testing.

All fuel designs are restrained in the Traveller during transport by means of similar clamshell systems that utilize positive restraint components. The restraint system includes a threaded top restraint mechanism, robust doors as well as top and bottom clamshell plates, and a system of door closure latches. Non-Westinghouse fuel assembly contents were approved based on the assumption that the performance of the packaging and resulting fuel assembly damage would be no worse than that demonstrated for the Westinghouse 17X17 XL. Non-Westinghouse fuel assembly types require a modified axial restraint at the top end and spacer under the fuel assembly to prevent axial movement of the fuel during normal transport.

Safety significant packaging features important to maintaining subcriticality include fuel assembly arrangement, neutron absorber, polyethylene moderator, and clamshell confinement geometry. The modified axial restraint components are similar to those used for the Westinghouse 17X17 XL fuel. Use of the modified axial restrain is presumed to not alter the assumptions about performance of the fuel assembly or safety significant packaging features during the accident test conditions.

An evaluation of mechanical response for non-Westinghouse fuel assemblies that are subjected to the hypothetical accident condition 9-meter drop test in a Traveller packaging is presented to demonstrate the presupposition about performance of the fuel assembly and safety significant packaging features during the accident test conditions. The mechanical response of non-Westinghouse fuel assembly types, herein called CE and ATOM fuel assemblies, is evaluated by comparison to performance of the Westinghouse fuel assembly contents in the Certification Test Unit (CTU) drop test. The non-Westinghouse fuel assemblies with the modified restraint components should perform consistent with the performance of 17x17 XL fuel assemblies tested in the Traveller CTU test.

Assumptions

This analysis examines the differences in the overall forces involved in hypothetical accidents for a Traveller shipping package loaded with a CE or ATOM type PWR fuel assembly rather than the Westinghouse 17x17-XL fuel assembly, which was used in the Traveller CTU test. Note that even though the top end drop scenario will be discussed, the calculations use the Traveller SAR assumption that the 30 ft (9 m) bottom nozzle end drop is most likely to cause serious damage to the package.

The design and licensing weight of 5100 pounds (Table 2) was determined to be the bounding packaging and content weight. During the testing phase of licensing, the associated energy of 5100 pounds dropped from 9 meters was used as the basis for determining the drop height of the CTU. As a result of the actual test weight of the CTU being less than the design weight

(4863 pounds from Table 2), the drop test height of the CTU package was determined to be 10.0 meters.

In order to compare expected responses of non-Westinghouse fuel assemblies to the 17x17 XL responses, the CTU drop test kinetic energy and resultant force were normalized to reflect responses to a 9 meter drop test. This simplified the comparison with non-Westinghouse fuel configurations and allowed the drop test kinetic energies and resultant forces to be compared. The normalized kinetic energies and resulting peak forces between the clamshell and the internal pillow within the Traveller outerpack are shown in Table 1. They demonstrate that the CTU test bounds the anticipated conditions for similar conditions with ATOM and CE fuel designs.

Table 1: Estimated Clamshell/FA Impact Energy and Resulting Peak Forces

Fuel Assembly Design	Normalized 9-meter Kinetic Energy (Ft-lbs)	Normalized 9-meter Force (lbs)
CTU – 17x17XL Fuel	71,900	566,000
CE Fuel	58,600	512,000
ATOM Fuel	70,500	561,000

Methodology

Analyzing predicted damage to the Traveller resulting from the 30 foot drop test is complex because there are two relatively independent "systems" to consider, namely the fuel assembly-clamshell system and the outerpack system. In order to simplify the analysis, potential damage to each system is considered separately.

Damage to the outerpack is considered first. For any drop orientation, damage to the outerpack is a function of the total weight of the package. If the anticipated weight is less than the weight used in the drop tests, the drop tests bound the damage anticipated.

Damage to the clamshell is more difficult to quantify. For drop orientations other than the top end drop, if the internal weight used in the actual drop tests bounds the anticipated weight, the damage to the clamshell observed in the drop tests will be bounding. The top end drop is, however, a special case. During the top end drop, the outerpack hits the ground and stops while the clamshell and fuel assembly continue to fall. Next the clamshell hits the internal pillow in the outerpack and decelerates. The deceleration experienced by the fuel assembly at this time depends on the amount of force that is transmitted through the top restraint assembly. If the top restraint system buckles very quickly, the fuel assembly does not decelerate significantly until the top restraint system is completely compressed and the fuel assembly hits the top door of the clamshell. If the force transmitted through the top restraint system is small enough, the small initial pillow deformation may be sufficiently elastic to cause the clamshell to rebound. (It should be noted that this was not observed in any Traveller test but may be theoretically possible.) This could potentially cause the fuel assembly to hit the clamshell top head when it is not touching the pillow increasing the loads on the bolts holding the clamshell top head. Therefore, one part of the analysis below examines the force needed to buckle the top restraint system and compare it with the calculated force needed to buckle the top restraint system used in the CTU drop tests. In addition, the total forces on the clamshell are determined using the energy method.

Evaluations, Analysis, and Detailed Calculations

Outerpack Damage

The actual weights of the CTU versus the design and licensing basis gross weights are shown in Table 2. The actual fuel assembly drop test weight was 1752 lb compared to the design and licensing basis gross weight of 1971 lb. According to Table 2-44 in the Traveller SAR, the CTU was dropped from 32 ft – 10 inches (10.0 m) in order to equal the energy associated with the design and licensing basis weight dropped from 9-meters. Attention is focused on this test because the 9.0 meter drop was performed vertically on the bottom nozzle end of the package, resulting in the worst fuel assembly deformations.

Table 2: CTU Actual and Design Test Weights

Component	CTU Actual Wt (lb)	CTU Design Wt (lb)
Outerpack (empty)	2671	2633
Clamshell (empty)	440	467
Packaging (Outerpack + Clamshell)	3111	3100
Fuel Assembly	1752	1971
Total Package (Packaging + Fuel)	4863	5071
Design and Licensing Basis Gross Weight		5100
Design Tare Weight (Design and Licensing Gross Weight less Fuel Assembly)		3129

The Traveller will transport three CE fuel assembly designs, all of which are significantly shorter than the Westinghouse fuel assemblies. Therefore a bottom spacer, shown in Figure 1, will support the fuel. This bottom spacer is composed of six major pieces: bottom rubber pad, two stainless steel base plates, stainless steel support pipe, top pad, and rod handle. Data for the bottom spacer components are given in Table 3. Total weight for the bottom restraint system is 34.5 lb.

Table 3: Bottom Spacer Data

Bottom Spacer Component	Dimensions (in)	Material	Density (lb/in3)	Weight (lb)
Bottom Pad	9.0 x 9.0 x 1.25	Neoprene rubber	0.0368	3.7
Top Base Plate	9.0 x 9.0 x 0.5	Stainless steel	0.2890	11.7
Bottom Base Plate	9.0 x 9.0 x 0.5	Stainless steel	0.2890	11.7
Support Pipe	6.625 OD 6.065 ID 3.75 L	Stainless steel	0.2890	6.0
Top Pad	9.0 x 9.0 x 0.375	Neoprene rubber	0.0368	1.1
Rod Handle	0.5 OD 4.75 L	Stainless steel	0.2890	0.3
Total Weight				34.5

The CE fuel will use a variant top restraint system, also shown in Figure 1. The major components of the restraint system include: an axial clamp arm, clamp arm extension, threaded rod, clamp arm extension, axial base plate, and bottom pad. Data for the bottom spacer components are given in Table 4. The total weight for the top restraint system is 7.5 lb.

Table 4: Top Restraint System Assembly Data

Top Restraint System Component	Dimensions (in)	Material	Density (lb/in3)	Weight (lb)
Axial Clam Arm	1.00 1.25 x 7.00	Stainless steel	0.2890	2.50
Threaded Rod	0.75 OD 5.875 L	Stainless steel	0.2890	0.76
Clamp Arm Extension (with hole for 0.75 inch threaded rod)	1.25 x 2.00 x 0.75	Stainless steel	0.2890	0.40
Axial Base Plate (Overall)	8.50 x 8.50 x 1.25	Aluminum	0.0983	3.50
Bottom Plate	8.50 x 8.50 x 0.25			
Central Riser	2.00 x 2.00 x 1.00			
Ribs (4)	0.71" x 0.5 x (8.50" – 2.00") x 1.414			
Bottom Pad	8.50 x 8.50 x 0.25	Neoprene rubber	0.0368	0.70
Total Weight				7.50

Table 5 shows the comparison weights of the CTU design data and the CE and ATOM fuel design data. The total weight of the CE fuel assembly is 1500 lb. Note that this is significantly less than both the actual CTU fuel assembly weight (1752 lb) and the CTU design weight (1971 lb). When the internal components of the clamshell are added to the fuel assembly, the total weight of heaviest CE fuel assembly and Traveller packaging is less than the CTU total design weight (4611 lb versus 5071 lb). Because the total loads on the outerpack are so much less than the tested weight, the CTU test is bounding.

The Traveller will also transport the 16x16 and 18x18 ATOM fuel assemblies. These will require the same top restraint system as the CE fuel but they will not require a bottom spacer assembly. The maximum total weight of the ATOM fuel design and top axial restraint assembly is 1940 + 7.5 = 1948 lb. Like the CE fuel design, this weight is also less than the design CTU weight (1971 lb). The total weight of heaviest ATOM fuel assembly and Traveller packaging is less than the CTU total design weight (5051 lb versus 5071 lb). Therefore, the total force and resulting damage to the outerpack from a 9.0 m drop with the ATOM fuel would be less than the force and damage from the CTU drop.

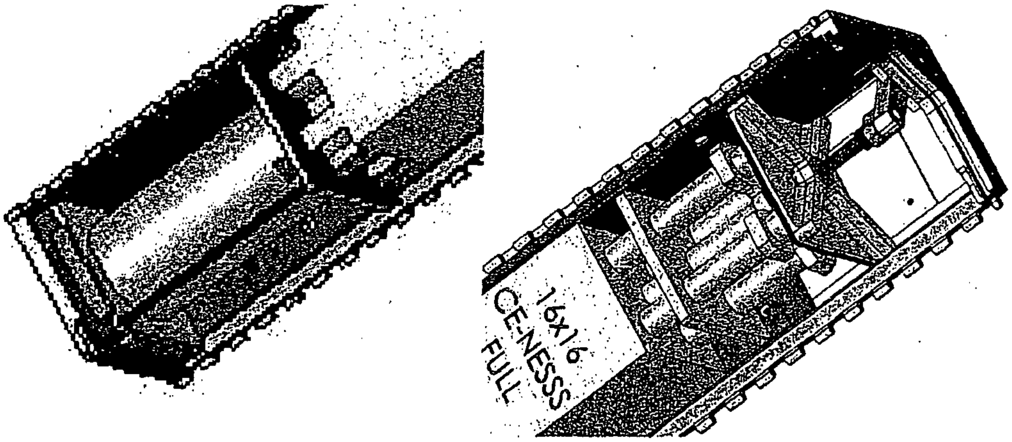

Figure 1: Bottom Spacer for CE Assembly (left) and Top Restraint System (right) for Non-Westinghouse Fuel (CE and ATOM)

Table 5: Comparative Test Weights (CTU, CE, ATOM)

Component	CTU Actual. Wt (lb)	CTU Design Wt (lb)	CE Analyzed Fuel (lb)	ATOM Analyzed Fuel (lb)
Outerpack (empty)	2671	2633		
Clamshell (empty)	440	467	483	448
Packaging (Outerpack + Clamshell)	3111	3100	3111	3111
Fuel Assembly	1752	1971	1500	1940
Clamshell + Fuel Assembly	2192	2438	1983	2388
Total Package (Packaging + Fuel)	4863	5071	4611	5051
Design and Licensing Basis Gross Weight		5100		

Clamshell Damage – Bottom Nozzle End Drop

Clamshell damage in a 9 meter drop results from the total amount of force applied to it and the timing of the forces applied to selected parts of it. As demonstrated above, because the CE and ATOM fuel assembly designs are lighter than the CTU fuel assembly, the total loads imposed on the clamshell would be less than those experienced in the CTU tests. The primary concern, therefore, is the timing of the forces imposed by the FA during the impact. During an end drop, the sequence of impacts is as follows:

1. First, the outerpack hits the pad, decelerates, and stops as the outside foam compresses.

2. Next, the clamshell hits the internal pillow in the outerpack, which is designed to control the deceleration of the clamshell.

3. Finally, the fuel assembly, in contact with the clamshell by the top restraint system, decelerates and stops as the fuel assembly and/or the top restraint system absorbs the fuel assembly's kinetic energy.

The outerpack foam and internal pillow are designed so that deformations are plastic, producing very little rebound. In a bottom nozzle end drop, the fuel assembly remains in contact with the end of the clamshell. At impact, the deceleration force is transmitted from the pillow through the clamshell bottom head directly to the fuel assembly.

For a bottom nozzle end drop performed with the CE fuel design, the 6" schedule 40 pipe in the bottom spacer assembly is the only component that might be likely to buckle. The longest version that will be used is 13.25" long. The longer pipe is used since it is more prone to buckling, but the heaviest CE fuel assembly is used to bound the fuel types by weight. This combination is the most conservative combination of fuel types and support pipes. The pipe has an OD of 6.625", an ID of 6.065" and a cross-section area of 5.58 in^2. Using the Rankin formula for short columns with both ends fixed:

$$P = S \times A / [1+K (l^2 / r^2)]$$

Where:

P is the maximum load before buckling

S is the yield strength (35,000 psi)

K = is the Rankine coefficient = 0.00004 for columns with both ends fixed

Therefore:

$$P = 35{,}000 \times 5.58 / [1 + 0.00004 \times (13.25^2 / 3.3125^2) = 195{,}000 \text{ lb}$$

This is equivalent to the load of a 1500 lb FA decelerating at 130 g. Some buckling of the fuel spacer assembly may occur but load will be transferred from the impact pillow in the outerpack through the clamshell bottom head to the fuel assembly. The fuel assembly is never in free-fall and will not impact the clamshell bottom head with a significant differential velocity.

Clamshell Damage – Top Nozzle End Drop

In a top nozzle end drop, the deceleration force is transmitted from the pillow to the fuel assembly through the clamshell top head and top restraint system. The top restraint system deforms as it absorbs energy, which means that the fuel assembly continues to move. The force needed to deform the top restraint system must be sufficient to prevent significant rebound of the clamshell from the pillow. If this force is insufficient, the clamshell may rebound, resulting in a higher impact velocity with the fuel assembly top nozzle. This collision would occur when the clamshell top head cannot transmit the resulting impulse directly to the outerpack pillow, increasing the load on the clamshell top head bolts. If sufficient force is transmitted through the top restraint system to prevent clamshell rebound, the forces on the clamshell top end bolts are very small. That is because the loads from the fuel assembly (the dominant mass) are transmitted directly through the clamshell head to the pillow.

The top restraint system in the CTU drop test incorporates a clamp arm with two tubes at each end, as shown in Figure 2. The tubes are 0.75" outside diameter and are drilled and tapped to accept a 0.625-11 threaded rod. The tube is 4.5" long. The threaded rod (not including the support pads) is 6.075". Total length below the clamp arm is 9.56" including the 0.92" foot. While shipping a 17x17 XL fuel assembly, approximately 1.94" of the .625-11 rods are threaded into the 0.75" tube.

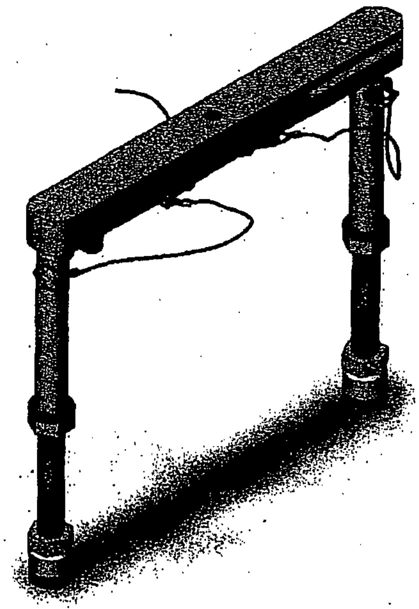

Figure 2: Top Restraint System For Westinghouse Fuel Assemblies

The cross section areas of the threaded rod and the tube are approximately 0.307 in^2 and 0.135 in^2 respectively. The total column length is approximately 8.64 in. The resulting slenderness ratio (based on the tube diameter) is

$$L/r = 8.64/(0.75/2) = 23.0$$

The general definition of a short column is one where the L/r is less than 100. This is clearly the case for the two legs of the 17x17 top restraint system. The allowable yield strength of ASTM A240 type 304 stainless steel is equal to or greater than 30,000 psi. Rankine's formula for short columns is for columns with L/r between 20 and 120, can be used to provide a simple comparison between top restraint systems. For the 17x17 top restraint system used in the CTU test:

$$P = S \times A / [1 + K \times (L^2/r^2)]$$ where:

P is the maximum load before buckling

S is the yield strength (30,000 psi)

K = is the Rankine coefficient = 0.00064 for columns with one end fixed and one end free

P is calculated to be 3100 lbs. Because two clamp arms are used, total load before buckling is 6200 lbs.

The top restraint system to be used with non-Westinghouse fuel uses a 0.75" threaded rod. Four different rod lengths are used, with the longest having a total length of 5.875". Ignoring the length of the rod supported by the axial clamp arm and the axial base plate the maximum load before buckling is:

$$P = 30{,}000 \times 0.442 / [1 + 0.00064 \times (5.875^2 / 0.375^2)] = 11{,}500 \text{ lbs}$$

The CE top restraint system is substantially stronger than the top restraint system used in the CTU test. This would allow more force from the outerpack impact pillow through the top restraint system to the fuel assembly and should prevent rebound of the clamshell during the top end drop.

The transport of the heavier ATOM fuel assemblies will increase the load on the top restraint system in a top nozzle end drop. The top restraint system maximum load before buckling is 85% higher than the CTU top restraint system. Therefore, the top restraint system will buckle later for the ATOM fuel than in the CTU test. This delay in buckling assures that the force decelerating the fuel assembly in a top end drop will prevent the clamshell from rebounding from the outerpack end pillow.

Total Forces in Clamshell

As described above, in CTU drop test, the total weight of the clamshell and fuel assembly was 2192 lb:

Clamshell: 440 lb

Fuel assembly: 1752 lb

Drop time can be calculated as:

$T = (2\ h / g)^{0.5}$, where h is the drop height and g is the acceleration of gravity.

$T = (2 \times 32.8 / 32.2)^{0.5} = 1.427$ seconds

Impact velocity can be calculated as:

$V = (g)(t)$, where t is time and g is the acceleration of gravity.

$V = 32.2 \times 1.427 = 45.96$ ft/s

Therefore the total kinetic energy of the clamshell and fuel assembly can be calculated as:

$KE = 1/2\ (m)\ (V)^2$, where m is mass and V is velocity. For correct units, the right-hand side of the equation must be divided by g_c (32.2 ft/s^2).

$KE = 0.5 \times (2192) \times 45.96^2 / 32.2 = 71{,}900$ ft-lb

The pillow beneath the clamshell was initially 3.6 inches thick and the spun-formed cylinder that contained had a bottom thickness of approximately 0.05 inches. During the drop test, the pillow compressed to approximately 1.8 inches thick or approximately 50% of its initial thickness. See Figure 3. For the foam density used, this corresponds to a peak crush strength of 240 psi. The average crush strength over the range from 10% strain to 50% strain is 203 psi. Deceleration was, therefore, relatively constant with the peak deceleration only 1.18 x the average. If deformation of the higher density foam in the outerpack beneath the pillow is ignored, average deceleration time can be calculated as:

$$T = 2 \times (1.8 / 12) / 45.96 \text{ ft/s} = 0.00653 \text{ seconds.}$$

Average deceleration can therefore be calculated as:

$$A = 45.96 \text{ ft/s} / (0.0065 \text{ s} \times 32.2 \text{ ft/s}^2) = 219 \text{ g}$$

Peak deceleration can be estimated as:

$$A_{peak} = 219 \times 1.18 = 258 \text{ g}$$

Figure 3: CTU Bottom Pillow after Hypothetical Accident Testing

The maximum force needed to decelerate the clamshell and fuel assembly at 258 g is approximately:

$$F = 258\text{g} \times 2192 \text{ lb} = 566{,}000 \text{ lb}$$

Because 80% of the mass being decelerated is the fuel assembly, this load is transferred directly through the bottom clamshell head directly into the pillow with insignificant lateral loads on the clamshell walls and minimal loads on the bolts holding the clamshell bottom plate to the sides of the clamshell. Visual examination of the clamshell after the testing showed minimal damage to the aluminum structure and all bolts and latches remained in place and the doors were closed.

If the same package is dropped from 29.53 ft (9.0 m) with the heaviest CE fuel and associated spacer, the total weight of clamshell and internals would be:

$$M = 440 \text{ (clamshell)} + 1500 \text{ (FA)} + 35 \text{ (spacer)} + 7.5 \text{ (top restraint system)} = 1983 \text{ lb}$$

Using the same equations above, the drop time would be 1.354 seconds and the peak velocity would be 43.61 ft/s. Total kinetic energy would be 58,600 ft-lbs.

Strain energy is defined as the force times the deflection of the object. Because 7 lb/ft^3 Last-A-Foam has an almost constant crush strength between 10% and 50% strain, total deflection can be approximated as proportional to the kinetic energy of the object striking the pillow. The crush of the pillow can therefore be estimated as:

$$D_{CE\ fuel} = D_{CTU} \times KE_{CE\ fuel} / KE_{CTU} = 1.47 \text{ inches or } 41\% \text{ crush}$$

Because the deceleration takes place over a shorter distance, deceleration time (0.00561 seconds) is shorter and the average deceleration itself is higher (241 g). The peak acceleration is closer to the average acceleration (1.07) so the peak acceleration is approximately 258 g's. Note that, coincidentally, this is the same value calculated for the CTU test. The maximum force exerted on the clamshell and contents is therefore approximately 512,000 lbs or 90% of the total force calculated for the CTU test.

If the same package were dropped from 29.53 ft (9.0 m) with the heaviest ATOM fuel and associated a top restraint system, the total weight of the clamshell system would be:

$$M = 440 \text{ (clamshell)} + 1940 \text{ (FA)} + 7.5 \text{ (top restraint system)} = 2318 \text{ lb}$$

The drop time and impact velocity would be the same as the CE case described above, so the total kinetic energy would be 70,500 ft-lb. The anticipated crush within the pillow would be 1.77 inches or 49% crush. Deceleration time and rate are 0.00678 seconds and 200 g's respectively.

Peak crush strength is 237 psi and the average crush strength is 202 psi so the peak is 117% of the average. Therefore the peak deceleration can be estimated as 235 g's. The maximum force exerted on the clamshell and contents is therefore approximately 561,000 lbs or 99% of the force calculated for the CTU test. Therefore, the CTU test bound both scenarios.

It should be noted that significant conservatism is used in these calculations. Decelerations due to the shock mounts and the foam beneath the pillow will increase the total deceleration time and reduce the peak deceleration and forces.

Conclusions

For both non-Westinghouse fuel types, total loads on the Traveller outerpack and clamshell were examined. Weights associated with top restraint systems and axial spacers were included in this assessment. Potential clamshell damage due to timing of clamshell impact and elastic rebound was also examined. As a result, the following conclusions can be made for normalized 9-meter drop tests:

For CE fuel with associated clamshell internals, the calculated kinetic energy is substantially less than observed in the CTU test. As a result overall forces on the outerpack and clamshell are less than observed in the CTU test.

For ATOM fuel with associated clamshell internals, the calculated kinetic energy is less than the kinetic energy observed in the CTU test. As a result overall forces on the outerpack and clamshell are less than observed in the CTU test.

The top restraint system used for non-Westinghouse fuel is stiffer than the assembly used in the CTU test. The axial spacer is much stiffer. Therefore, in the event of an end drop, the clamshell is less likely to rebound from the pillow during the collapse of the clamp assembly with non-Westinghouse fuel than in the CTU test configuration. This insures that the clamshell end plates are fully supported during the accident.

The CTU test showed no visible plastic deformation of the clamshell and the clamshell doors remained fully closed when tested with a lead-filled 17x17 XL fuel assembly. Because the majority of the mass being decelerated is the fuel assembly, this load is transferred directly through the bottom clamshell head directly into the pillow with insignificant lateral loads on the clamshell walls and minimal loads on the bolts holding the clamshell bottom plate to the sides of the clamshell. Visual examination of the clamshell after the testing showed minimal damage to the aluminum structure and all bolts and latches remained in place and the doors were closed.

Enclosure 2. Proposed wording for Certificate of Compliance USA/9297/AF-96

5.a.(3) Drawings

The packaging are fabricated and assembled in accordance with the following Westinghouse Electric Company Drawing Nos.:

10004E58 Rev.4 (Sheets1-8)
10006E58 Rev.5
10006E59 Rev.1 (Sheets1-2)

Enclosure 3. Pages affected in License Application

ADD	REMOVE
1-5 and 1-5A (Rev. 6/2004)	1-5 Rev. 0, (3/2004)
1-6 (Rev. 0, 3/2004),1-6A (Rev. 1, 11/2004)	1-6, (Rev. 0, 3/2004), 1-6A and 1-6B (Rev. 1, 11/2004)
10004E58, Rev. 4 (SHEET 1 to SHEET 8)	10004E58, Rev. 3 (SHEET 1 to SHEET 8)

The following changes were made to package drawings in Appendix 1.4:

10004E58, Rev. 3, "Safety Related Items Traveller XL & STD"

SHEET 1

1. Add new note E: "ITEM 152 USED TO FACILITATE TRANSPORT OF CE TYPE PWR FUEL DESIGNS, B&W TYPE PWR FUEL DESIGNS AND ATOM TYPE PWR FUEL DESIGNS."

2. In the BoM, add new Item 152 with the following information:

    2a: In the Part Name Column add "ALT. TOP AXIAL RESTRAINT",
    2b: In the Note Column add "E", and
    2c: In the quantity box add "AR".
    2d: In the (Size) Reference Information Column add "ASTM B209/B221 6061-T6 ALUMINUM"

SHEET 7

1. Near Zone G7, add depiction of Item 152 and associated note as shown on the attached sheet (new sheet 7 of 8).

2. Near Zones C7/D7 and B8, add depiction of the optional axial spacer and associated note as shown on the attached sheet (new sheet 7 of 8).

Enclosure 4. Previous Version of Certificate of Compliance USA/9297/AF-96 including NRC SER

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 25, 2006

Mr. Norman A. Kent
Manager Transport Licensing and Regulation Compliance
Nuclear Material Supply
Westinghouse Electric Company
P.O. Drawer R
Columbia, South Carolina 29250

SUBJECT: CERTIFICATE OF COMPLIANCE NO. 9297, REV. NO. 1, FOR MODEL NOS. TRAVELLER STD AND TRAVELLER XL (TAC NO. L23957)

Dear Mr. Kent:

As requested by your application dated March 17, 2006, and supplemented by letter dated March 17, 2006, enclosed is Certificate of Compliance (CoC) No. 9297, Revision No. 1, for the Model Nos. Traveller STD and Traveller XL. Changes made to the enclosed certificate are indicated by vertical lines in the margin. The staff's Safety Evaluation Report is also enclosed.

Westinghouse Electric Company is registered as the certificate holder of the package. The approval constitutes authority to use the package for shipment of radioactive material and for the package to be shipped in accordance with the provisions of 49 CFR §173.471.

If you have any questions regarding this certificate, please contact me at (301) 415-7298 or Stewart W. Brown of my staff at (301) 415-8531.

Sincerely,

Robert A. Nelson, Chief
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9297

Enclosures: 1. CoC No. 9297, Rev. No 1
2. Safety Evaluation Report

cc w/encls: R. Boyle, Department of Transportation
J. Schuler, Department of Energy
RAMCERTS

NRC FORM 618
(8-2000)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE		PAGES
9297	1	71-9297	USA/9297/AF-96	1	OF	6

2. PREAMBLE

a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO *(Name and Address)*

Westinghouse Electric Company
P.O. Drawer R
Columbia, SC 29250

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

Westinghouse Electric Company application dated April 1, 2004, as supplemented.

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.
(a) Packaging

(1) Model Nos.: Traveller STD and Traveller XL

(2) Description

The Traveller package is designed to transport non-irradiated uranium fuel assemblies or rods with enrichment up to 5.0 weight percent. The package is designed to carry one fuel assembly or one container for loose rods. The package consists of three components: 1) an outerpack, 2) a clamshell, and 3) a fuel assembly or rod container.

The outerpack is a structural component that serves as the primary impact and thermal protection for the fuel assembly or rod container. The outerpack has a long horizontal tubular design consisting of a top and bottom half. At each end of the package are thick limiters consisting of two sections of foam of different densities sandwiched between three layers of sheet metal. The impact limiters are integral parts of the outerpack and reduce damage to the contents during an end, or high-angle drop. The outerpack also provides for lifting, stacking, and tie down during transportation.

The clamshell is a horizontal structural component that serves to protect the contents during routine handling and in the event of an accident. The clamshell consists of an aluminum "V" extrusion, two aluminum door extrusions, and a small access door. Each extruded aluminum door is connected to the "V" extrusion with piano-type hinges (continuous hinges). These doors are held closed with a latching mechanism and quarter-turn bolts. Neutron absorber plates are installed in each leg of the "V" extrusion and in each of the doors. The "V" extrusion and the bottom plate are lined with a cork rubber pad to cushion and protect the contents during normal handling and transport conditions.

NRC FORM 618
(8-2000)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE	PAGES
9297	1	71-9297	USA/9297/AF-96	2 OF	6

5.(a)(2) Description (Continued)

The Traveller package is designed to carry loose rods using either of two types of rod containers: a rod box or rod pipe. The rod box is an ASTM, Type 304 stainless steel container of rectangular cross section with stiffening ribs located approximately every 60 centimeters (cm) (23.6 inches (in.)) along its length. It is secured by fastening a removable top cover to the container body using socket head cap screws. The rod pipe consists of a 15.2 cm (6 in.) standard 304 stainless steel, Schedule 40 pipe, and standard 304 stainless steel closures at each end. The closure is a 0.635 cm (0.25 in.) thick cover secured with Type 304 stainless steel hardware to a flange fabricated from 0.635 cm (0.25 in.) thick plate.

There are two models of the Traveller packaging, the Traveller STD and the Traveller XL.

Traveller STD:

Package gross weight	2,041 kilograms (kg) (4,500 pounds (lbs))
Packaging gross weight	1,293 kg (2,850 lbs)
Contents gross weight	748 kg (1,650 lbs)
Outer dimensions	
Length	500 cm (197 in.)
Width	68.6 cm (27.1 in.)
Height	100 cm (39.3 in.)

Traveller XL:

Package gross weight	2,313 kg (5,100 lbs)
Packaging gross weight	1,419 kg (3,129 lbs)
Contents gross weight	894 kg (1,971 lbs)
Outer dimensions	
Length	574 cm (226.1 in.)
Width	68.6 cm (27.1 in.)
Height	100 cm (39.3 in.)

(3) Drawings

The packagings are fabricated and assembled in accordance with the following Westinghouse Electric Company's Drawing Nos.:

10004E58, Rev. 3 (Sheets 1-8)
10006E58, Rev. 5
10006E59, Rev. 1 (Sheets 1-2)

(b) Contents (Type and Form of Material)

(1) Fuel Assembly

(i) Unirradiated PWR uranium dioxide fuel assemblies with a maximum uranium-235 enrichment of 5.0 weight percent. The parameters of the fuel assemblies that are permitted are as follows:

5.(b)(1)(i) Fuel Assembly (Continued)

Parameters for 14 x 14 Fuel Assemblies

Fuel Assembly Description	14 x 14	14 x 14	14 x 14
Fuel Assembly Type	W-STD	W-OFA	CE-1/CE-2
No. of Fuel Rods per Assembly	179	179	176
No. of Non-Fuel Rods	17	17	20
Nominal Guide Tube Wall Thickness	0.043 cm (0.017 in.)	0.043 cm (0.017 in.)	0.097 cm (0.038 in.)
Nominal Guide Tube Outer Diameter	1.369 cm (0.539 in.)	1.336 cm (0.526 in.)	2.822 cm (1.111 in.)
Nominal Pellet Diameter	0.929 cm (0.366 in.)	0.875 cm (0.344 in.)	0.956/0.966 cm (0.376/0.381 in.)
Nominal Clad Outer Diameter	1.072 cm (0.422 in.)	1.016 cm (0.400 in.)	1.118 cm (0.440 in.)
Nominal Clad Thickness	0.062 cm (0.024 in.)	0.062 cm (0.024 in.)	0.071/0.066 cm (0.028/0.026 in.)
Clad Material	Zirconium alloy	Zirconium alloy	Zirconium alloy
Nominal Assembly Envelope	19.70 cm (7.76 in.)	19.70 cm (7.76 in.)	20.60 cm (8.11 in.)
Nominal Lattice Pitch	1.412 cm (0.556 in.)	1.412 cm (0.556 in.)	1.473 cm (0.580 in.)

Parameters for 15 x 15 Fuel Assemblies

Fuel Assembly Description	15 x 15	15 x 15
Fuel Assembly Type	STD/OFA	B&W
No. of Fuel Rods per Assembly	205	208
No. of Non-Fuel Rods	20	17
Nominal Guide Tube Wall Thickness	0.043/0.043 cm (0.017/0.017 in.)	0.043 cm (0.017 in.)
Nominal Guide Tube Outer Diameter	1.387/1.354 cm (0.546/0.533 in.)	1.354 cm (0.533 in.)
Nominal Pellet Diameter	0.929 cm (0.366 in.)	0.929 cm (0.366 in.)
Nominal Clad Outer Diameter	1.072 cm (0.422 in.)	1.072 cm (0.422 in.)
Nominal Clad Thickness	0.062 cm (0.024 in.)	0.062 cm (0.024 in.)
Clad Material	Zirconium alloy	Zirconium alloy
Nominal Assembly Envelope	21.39 cm (8.42 in.)	21.66 cm (8.53 in.)
Nominal Lattice Pitch	1.430 cm (0.563 in.)	1.443 cm (0.568 in.)

5.(b)(1)(i) Fuel Assembly (Continued)

Parameters for 16 x 16 Fuel Assemblies

Fuel Assembly Description	16 x 16	16 x 16	16 x 16	16 x 16
Fuel Assembly Type	W-STD	CE	NGF	ATOM
No. of Fuel Rods per Assembly	235	236	235	236
No. of Non-Fuel Rods	21	20	21	20
Nominal Guide Tube Wall Thickness	0.046 cm (0.018 in.)	0.102 cm (0.040 in.)	0.041 cm (0.016 in.)	0.057 cm (0.023 in.)
Nominal Guide Tube Outer Diameter	1.196 cm (0.471 in.)	2.489 cm (0.980 in.)	1.204 cm (0.474 in.)	1.354 cm (0.533 in.)
Nominal Pellet Diameter	0.819 cm (0.323 in.)	0.826 cm (0.325 in.)	0.784 cm (0.309 in.)	0.914 cm (0.360 in.)
Nominal Clad Outer Diameter	0.950 cm (0.374 in.)	0.970 cm (0.382 in.)	0.914 cm (0.360 in.)	1.075 cm (0.423 in.)
Nominal Clad Thickness	0.057 cm (0.023 in.)	0.064 cm (0.025 in.)	0.057 cm (0.023 in.)	0.072 cm (0.029 in.)
Clad Material	Zirconium alloy	Zirconium alloy	Zirconium alloy	Zirconium alloy
Nominal Assembly Envelope	19.72 cm (7.76 in.)	20.68 cm (8.12 in.)	19.72 cm (7.76 in.)	22.95 cm (9.03 in.)
Nominal Lattice Pitch	1.232 cm (0.485 in.)	1.285 cm (0.506 in.)	1.232 cm (0.485 in.)	1.430 cm (0.563 in.)

Parameters for 17 x 17 and 18 x 18 Fuel Assemblies

Fuel Assembly Description	17 x 17	17 x 17	18 x 18
Fuel Assembly Type	W-STD/XL	W-OFA	ATOM
No. of Fuel Rods per Assembly	264	264	300
No. of Non-Fuel Rods	25	25	24
Nominal Guide Tube Wall Thickness	0.041/0.051 cm (0.016 /0.020 in.)	0.041 cm (0.016 in.)	0.065 cm (0.026 in.)
Nominal Guide Tube Outer Diameter	1.204/1.224/1.24 cm (0.474/0.482/0.488 in.)	1.204 cm (0.474 in.)	1.240 cm (0.488 in.)
Nominal Pellet Diameter	0.819 cm (0.323 in.)	0.784 cm (0.309 in.)	0.805 cm (0.317 in.)
Nominal Clad Outer Diameter	0.950 cm (0.374 in.)	0.914 cm (0.360 in.)	0.950 cm (0.374 in.)
Nominal Clad Thickness	0.057 cm (0.023 in.)	0.057 cm (0.023 in.)	0.064 cm (0.025 in.)
Clad Material	Zirconium alloy	Zirconium alloy	Zirconium alloy
Nominal Assembly Envelope	21.39 cm (8.42 in.)	21.39 cm (8.42 in.)	22.94 cm (9.03 in.)
Nominal Lattice Pitch	1.260 cm (0.496 in.)	1.260 cm (0.496 in.)	1.270 cm (0.500 in.)

5.(b)(1) Fuel Assembly (Continued)

(ii) Non-fissile base-plate mounted core components and spider-body core components are permitted.

(iii) Neutron sources or other radioactive material are not permitted.

(iv) Materials with moderating effectiveness greater than full density water are not permitted.

(v) There is no restriction on the length of top and bottom annular blankets.

(2) Loose Fuel Rods

Unirradiated uranium dioxide fuel rods with a maximum uranium-235 enrichment of 5.0 weight percent. Fuel rods shall be transported in the Traveller package inside either a rod pipe or rod box as specified in License Drawings 10006E58 or 10006E59, specified in Section 5(a)(3). The fuel rods shall meet the parametric requirements given below:

Parameter	Limit
Maximum Enrichment	5.0 weight percent uranium-235
Pellet diameter	0.508 – 1.524 cm (0.20 – 0.60 in.)
Maximum stack length	Up to rod container length
Cladding	Zirconium alloy
Integral absorber	Gadolinia, erbia, and boron
Wrapping or sleeving	Plastic or other material with moderating effectiveness no greater than full density water
Maximum number of rods per container	Up to rod container capacity

5.(c) Criticality Safety Index

(1) When transporting fuel assemblies: 0.7

(2) When transporting loose rods in a rod container: 0.0

NRC FORM 618
(8-2000)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE		PAGES
9297	1	71-9297	USA/9297/AF-96	6	OF	6

6. In addition to the requirements of Subpart G of 10 CFR Part 71:

   (a) The package must be prepared for shipment and operated in accordance with the Operating Procedures in Chapter 7 of the Traveller License Application, Revision 4.

   (b) Each packaging must be acceptance tested and maintained in accordance with the Acceptance Tests and Maintenance Program in Chapter 8 of the Traveller License Application, Revision 4.

7. The package authorized by this certificate is hereby authorized for use under the general license provisions of 10 CFR §71.17.

8. The package is not authorized by this certificate for air transport.

9. Revision No. 0 of this certificate may be used until April 30, 2007.

10. Expiration date: March 15, 2010.

REFERENCES

Westinghouse Electric Company application dated April 1, 2004.

Supplements dated: October 15 and November 16, 2004, and February 16, March 4, and March 10, 2005, and March 17 and April 12, 2006.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Robert A. Nelson, Chief
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Date: April 15 2006

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION REPORT

Docket No. 71-9297
Model Nos. Traveller STD and Traveller XL
Certificate of Compliance No. 9297
Revision No. 1

SUMMARY

By application dated March 17, 2006, as supplemented by letter dated April 12, 2006, Westinghouse Electric Company, LLC (Westinghouse or the applicant) submitted a request for amendment to Certificate of compliance (CoC) No. 9297, for the Model Nos. Traveller STD and Traveller XL. The request proposes to revise the weight limit and the associated licensing drawing for the loaded rod pipe for transporting loose fuel rods.

Based on the statements and representations in the application, the staff agrees that the changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

EVALUATION

The Traveller transportation packaging consists of two principal structural components: the outerpack and the clamshell. The outerpack provides impact and thermal protection for the package and the clamshell provides structural support for either a PWR fuel assembly or a rod container for loose fuel rods. The ASTM Type 304 stainless steel rod container was approved for two configurations: a 433.1-centimeter (cm) (170.5-inch (in.)) long rectangular rod box and a 12.7-cm (5-in.) or 15.2-cm (6-in.), Schedule 40 rod pipe of approximately the same length. Table 2.1 of the application summarizes the package weights, including the maximum fuel assembly weight of 748 kilograms (kg) (1,650 pounds (lbs)) for the Traveller STD package. Revision 1 of licensing Drawings 10006E58 and 10006E59, note an estimated weight of 300 kg (660 lbs) for the loaded rod pipe and rod box, respectively.

The applicant in its letter dated April 12, 2006, provided description of and justification for the proposed changes on implementing a rod pipe for transporting loose rods. The changes involve deleting use of the 12.7-cm (5-in.) rod pipe from the licensing drawing and increasing the weight limit of the loaded 15.2-cm (6-in.) rod pipe from 300 kg (660 lbs) to 748 kg (1,650 lbs), consistent with the maximum fuel assembly weight for the Traveller STD packaging. Revision 5 of licensing Drawing 10006E58 depicts the proposed pipe details, including three flanges, one in the middle and one at each end of the pipe, for restraining pipe motion inside the clamshell. As discussed in Section 1.2.1.4, common axial restraint to the fuel assembly, rod box, and rod pipe is provided by an axial arm bolted to the top clamshell shear lip and removable rubber pads of varying thickness are also introduced to accommodate the different fuel designs and rod containers.

Section 2.11.1 of the application examined the load path along the axial assemblage of the outerpack end cap, impact limiter, clamshell, and payload for dissipating the kinetic energy of the clamshell and its payload during an end drop test. By comparing the axial stiffness of a fuel assembly to that of a rod pipe and in recognizing the relatively small amount of energy dissipation due to partial rod buckling in the previous drop tests, the applicant stated that the rod pipe is expected to act in a coupled manner similar to the fuel assembly. As a result, the staff concludes that the structural confinement function of the clamshell with a loaded rod pipe is similar to that with single fuel assemblies. This permits a revised weight limit of 748 kg (1,650 lbs) for the loaded rod pipe. As previously evaluated the criticality analysis demonstrated that there is no limit on the number of rods that may be transported in a rod pipe based on criticality concerns.

CONCLUSION

Certificate of Compliance No. 9239 has been amended as follows:

- Condition No. 5(a)(2) of the certificate has been revised to include the following wording, "The rod pipe consists of a 15.2 cm (6 in.) standard 304 stainless steel, Schedule 40 pipe, and standard 304 stainless steel closures at each end. The closure is a 0.635 cm (0.25 in.) thick cover secured with Type 304 stainless steel hardware to a flange fabricated from 0.635 cm (0.25 in.) thick plate."
- Condition No. 5(a)(3) of the certificate has been revised to reflect revision to Drawing 10006E58.

Based on the statements and representations in the application the staff finds that these changes do not affect the ability of the Traveller package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9297,
Revision No. 1, on April 7, 2006.