71-9297

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-05-004
Your Ref:

Mr. Brown:

March 10, 2005

Subject: CERTIFICATE OF COMPLIANCE NO. 9297 FOR THE MODEL NO. TRAVELLER PACKAGE: SUBMISSION of REVISION 4 TO THE SAFETY ANALYSIS REPORT (SAR)

Attached please find Revision 4 to the Safety Analysis Report (SAR), provided in response to the most recent request for additional information. It was agreed that the SAR would be revised to clarify the following:

- Correct entries in various tables that list the Traveller design weights;
- Clarify in Sections 2 and 3 that the shock mounts were intact following the drop and fire tests;
- Provide justification in Section 2 for establishing payload weights that are higher than fuel assembly weights used in actual testing.

Enclosed please find the change pages that make up revision 4 to the SAR, including the revised list of effective pages. Please direct any questions to the me at (803) 647-3552.

Sincerely,
WESTINGHOUSE ELECTRIC COMPANY, LLC

Norman A. Kent

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

Enclosure: Rev 4 Change pages

NMSS01

A BNFL Group company

Westinghouse Electric Company, LLC
Columbia Fuel Fabrication Plant
Columbia, SC

Application for Certificate of Compliance for the Traveller PWR Fuel Shipping Package

NRC Certificate of Compliance

USA/9297/AF-96

Docket 71-9297

Initial Submittal: March 2004
Revision 1: November 2004
Revision 2: February 2005
Revision 3: March 2005
Revision 4: March 2005

Westinghouse

TABLE OF CONTENTS

Standard fabrication methods are utilized to fabricate the Traveller-series of packages. Visual weld examinations are performed on all welds of the Traveller packages in accordance with AWS D1.6. and ASME Section III, Subsection NF-5360, for stainless steel and aluminum respectively.

2.1.2 Design Criteria

2.1.2.1 Basic Design Criteria

Evidence of performance for the Traveller XL package is achieved by (1) empirical evaluations using full-scale packages and (2) large-strain capable Finite Element Analysis (FEA). The Traveller XL is bounding due to its increased weight and length when compared to Traveller STD. The criteria that was used for impact evaluation is a demonstration that the containment and confinement systems maintain integrity throughout Normal Conditions of Transport (NCT) and Hypothetical Accident Condition (HAC) certification testing. That is, it is necessary to demonstrate that there is no release of material, no loss of moderator or neutron absorber, no decrease in Outerpack geometry, and no increase in Clamshell geometry. The as-found condition of the package (packaging and contents) is the baseline configuration for the criticality safety evaluation that can be found in Chapter 6, Criticality Evaluation.

A detailed discussion related to Traveller XL design criteria, can be found in Appendix 2.12.2, Mechanical Design Calculations for the Traveller XL Shipping Package.

2.1.2.2 Miscellaneous Structural Failure Modes

2.1.2.2.1 Brittle Fracture

The primary structural materials of the Traveller packages are austenitic stainless steel (ASTM A240 Type 304 SS) and 6000 Series aluminum (extruded components 6005-T5, all else 6061-T6). These materials do not undergo a ductile-to-brittle transition in the temperature range of interest [i.e., down to -40°F (-40°C)], and thus do not require evaluation for brittle fracture.

2.1.2.2.2 Fatigue

Because the shells of the Outerpack are constructed of ductile stainless steel and they are formed into a very stiff body with low resulting stresses, no structural failures of the Outerpack due to fatigue will occur. Because the Clamshell is structurally isolated from the Outerpack through the rubber shock mounts, no Clamshell fatigue will occur. The Clamshell is, for practical purposes, decoupled from the Outerpack through the rubber shock mounts. These rubber shock mounts also provide excellent damping to the Clamshell.

2.1.2.2.3 Buckling

For normal condition and hypothetical accident conditions, the Clamshell which structurally encloses the fuel, will not buckle due to free or puncture drops. This behavior has been demonstrated via full-scale testing of the bounding Traveller XL package.

2.12 APPENDIX

2.12.1 Container Weights and Centers of Gravity

2.12.2 Mechanical Design Calculations for the Traveller XL Shipping Package

2.12.3 Drop Analysis for the Traveller XL Shipping Package

2.12.4 Traveller Drop Tests Results

Table 2-8 Summary of Traveller Mechanical Analysis

Requirement Description	Allowable Design Value(s) or Acceptance Criteria	Calculated Value	Acceptable
Lifting attachments	Tensile Yield Stress, $\sigma_y < 30$ ksi Shear Yield Stress, $\tau_y < 18$ ksi Weld shear Yield Stress, $\tau_y < 12$ ksi Hoist Screw Shear Stress, $\tau < 60$ ksi	Hole tear: $\tau = 5.1$ ksi< 18 ksi Weld: $\tau = 9.5$ ksi< 12 ksi (Alt. 8.1 ksi< 12 ksi) Hoist: $\tau = 49.4$ ksi< 60 ksi	Yes, for all
Tie-Down devices	NA	No tie down systems on package	Yes
Design temperatures between −40°F (-40°C) and 158°F (70°C)	No brittle fracture No impact from Differential Thermal Expansion (DTE)	No Impact	Yes
Internal/External Pressure	NA $\sigma_y < 30$ ksi	No stress developed	Yes
Vibration	NA	No impact, 41 Hz > 3.7-8 Hz	Yes
Water spray	NA	No impact	Yes
Compression/ Stacking test	Weld shear Yield Stress, $\tau_y < 12$ ksi Critical Buckling, $F < P_{cr}$	4.0 ksi < 12 ksi Outerpack; 25.5 ksi < 78.6 ksi Leg Support; 3.2 ksi < 26.9 ksi	Yes, for all
Penetration	NA	Bounded by 1.0m HAC pin-puncture; No perforation of outer skin.	Yes
Immersion	NA	No stress developed	Yes

Assumptions

The calculations to determine the maximum Outerpack allowable stresses for yield, shear, and weld shear are based on the properties of ASTM A240 Type 304 Stainless Steel. It is further assumed that the weld consumable possess greater mechanical properties than that of the base metal. Hence, the mechanical properties of the base metal will be employed for weld stress analysis. The reference drawings included in this analysis represent the Certification Test Unit (CTU) Traveller XL, which was fabricated for the drop and fire tests.

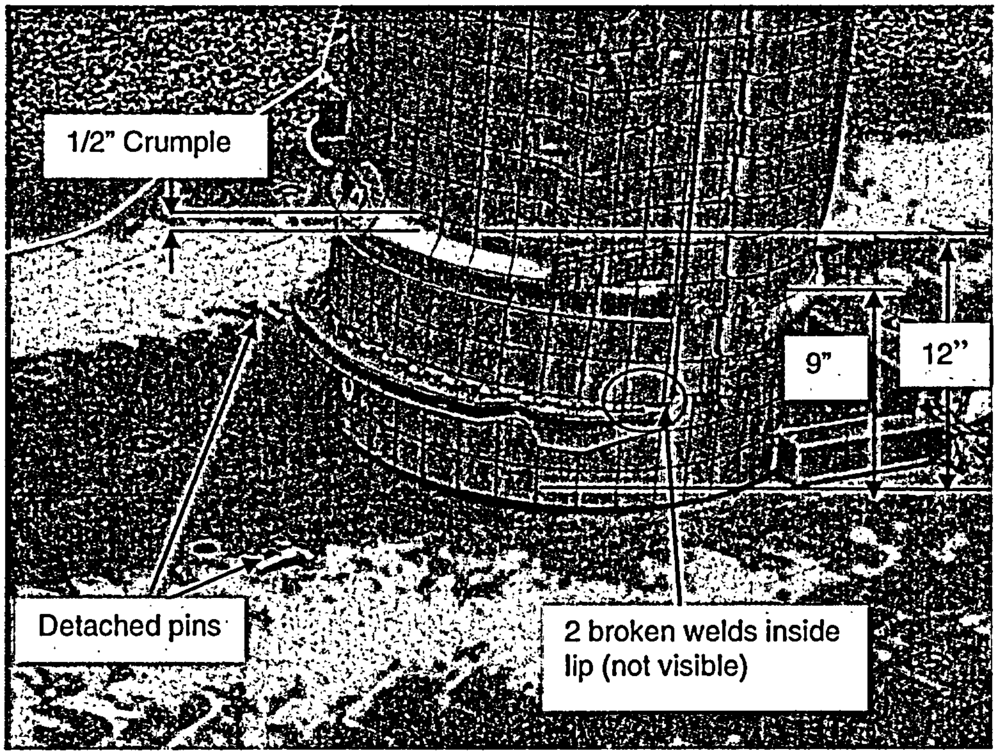

Figure 2-146 Bottom Nozzle End Cap Stiffener Damage From Test 2

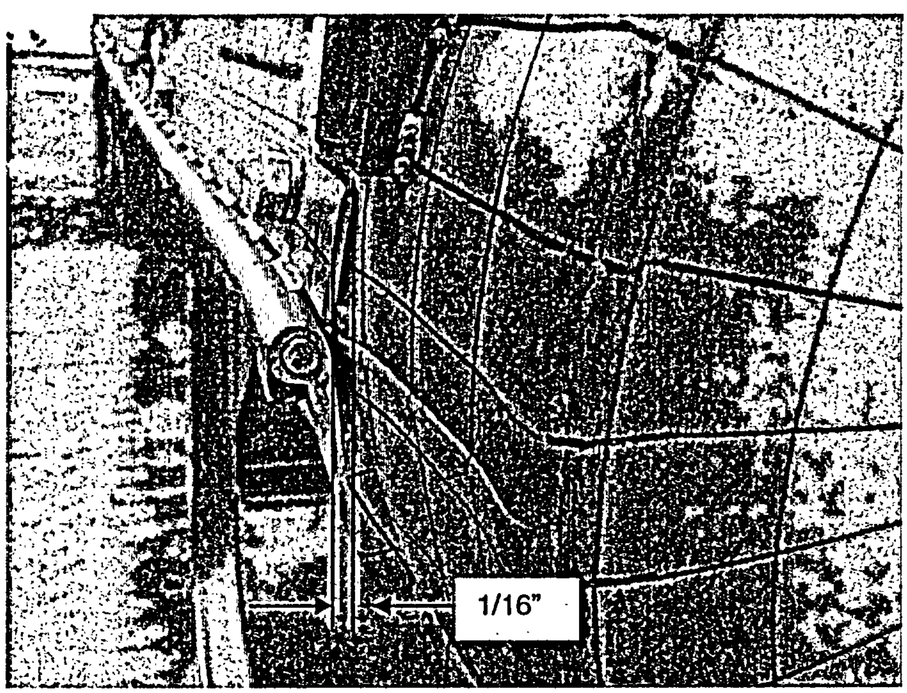

Figure 2-147 Hinge Separation at Bottom Nozzle End From Test 2

approximately 1/2". Otherwise, the typical pitch pattern consisted of 2 rod rows touching and the remaining 14 rows at nominal pitch, Figure 2-152.

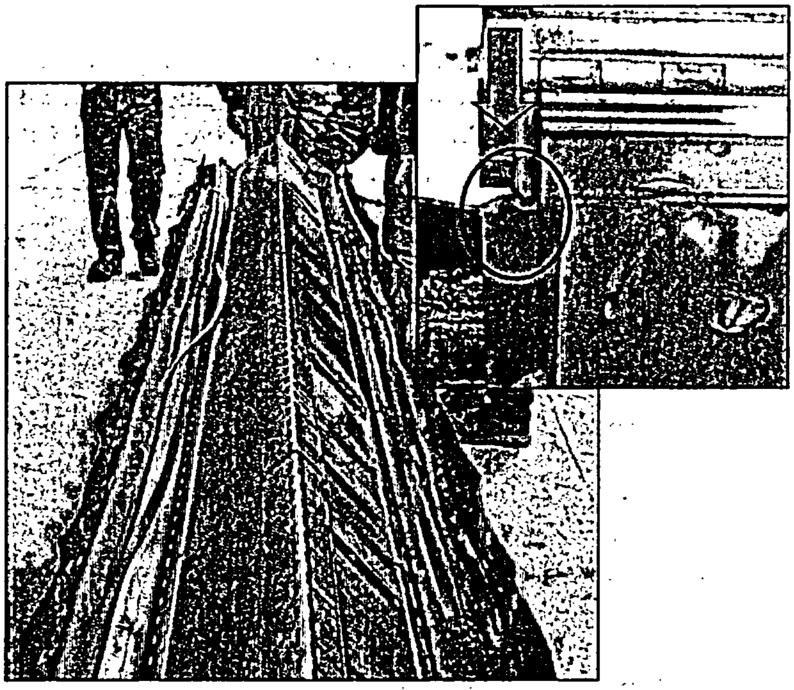

Figure 2-149 CTU Clamshell After Drop and Fire Tests

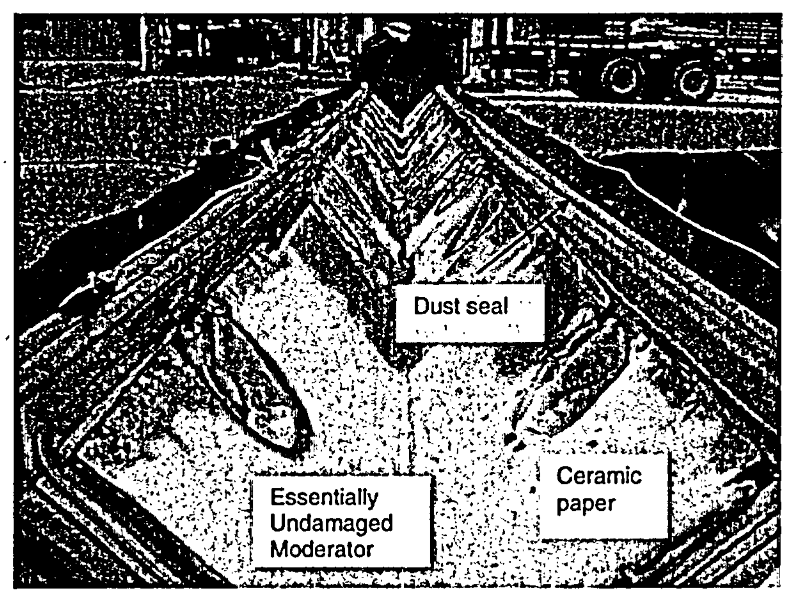

Figure 2-150 Outerpack Lid Moderator After Testing

Total wt. *4778 lbs*

Drop ht *33.4 ft (10.2 m)*

CTU – 9 m drop test

Outerpack wt. *2671 lbs*

Clamshell wt. *440 lbs*

FA wt. *1752 lbs*

Total wt. *4863 lb*

Drop ht *32.8 ft (10.0 m)*

Drop heights greater than 9 m were used to bound maximum possible weights and other uncertainties. Because potential energy is directly proportional to drop height the bounding weights for each test result as:

QTU-2 at 9 meters

FA wt. *2000 lb*

FA & Clamshell wt. *2453 lb*

Total package wt. *5409 lb*

CTU at 9 m

FA wt. *1947 lb*

FA & Clamshell wt. *2433 lb*

Total package wt. *5398 lb*

During the vertical drop, the fuel assembly remains stationary with respect to the clamshell until the clamshell hits the outerpack impact limiter and begins to decelerate. When the outerpack hits the ground, it quickly decelerates as the foam and outerpack metal skin absorb the outerpack kinetic energy. As shown Figures 2-136 and 2-137, the amount of deformation to the outerpack was very small with a total crush of the outside of the bottom impact limiter < 0.5 inches (averaged).

The dynamic characteristics of the actual test performed with QTU-2 from 10.2 m are slightly different than a 9.0 m drop of a heavier package (and heavier fuel assembly), as described below. The terminal velocity of the test was approximately 14.2 m/s instead of the 13.3 m/s from a 9.0 meter drop. This will result in slightly different impact times between the clamshell and outerpack. The magnitude of this difference can be estimated with the following assumptions:

This difference will not cause the clamshell to hit during the outerpack-rebound (approximately 10 milliseconds after clamshell contact) and the actual positions and velocities of the Traveller components will not be significantly different between the two drop scenarios.

The comparison above was made for the QTU-2 test. The general observations are applicable to the CTU tests however As a result, the QTU-2 and CTU test drops justify payload weights significantly higher than the 1767 and 1752 lb fuel assemblies actually used in the testing.

2.12.4.5 Conclusions

Three series of drop tests were performed during the development and certification of the Traveller shipping package. This included two prototype units, two qualification test units and one certification test unit. Design improvements were made at each step based on the results of the drop tests and subsequent fire tests. The drop test series included a regulatory normal free drop of 1.2 meters, a 9-meter end drop onto the bottom nozzle, and a 1-meter pin-puncture test on the hinge. Minor structural Outerpack damage indicated that the Traveller Outerpack design satisfied the hypothetical accident condition defined in 10 CFR 71 and TS-R-1. Furthermore, the Clamshell was found to meet the acceptance criteria of the test by maintaining closure and its pre-test shape. The post-test geometry of the fuel assembly was determined to meet the acceptance criteria since only local expansion was noted in the lower 20" of the bottom nozzle region and the cracked rod gaps were all measured less than a pellet diameter.

In summary, testing demonstrated the Traveller package is suitable for compliance to normal and hypothetical mechanical drop test conditions described in 10 CFR 71 and TS-R-1.

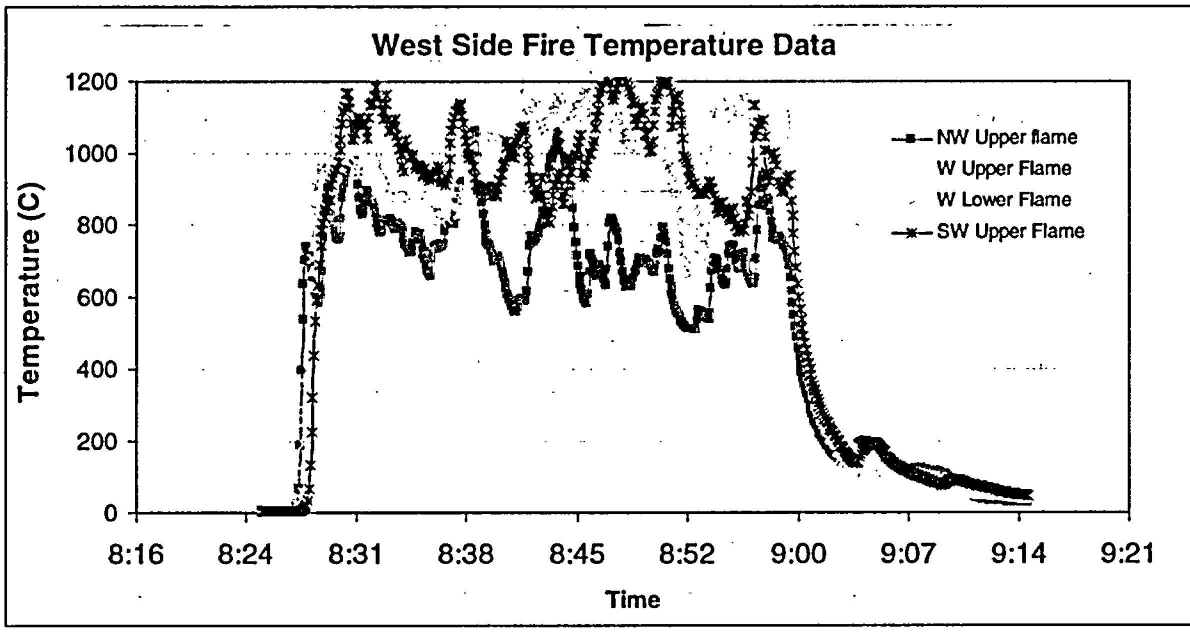

Figure 3-42 Fire Temperature Data from West Side of CTU

Temperature data was also collected using two portable, single wavelength optical thermometers. One was located on a raised platform on the west side of the package. The second was located on the east side of the package. Temperature data was recorded by hand. This data is shown in Tables 3-5 and 3-6.

Table 3-5 Optical Thermometer Data Sheet (West Side, Degrees C)

Time After Pool Fire Ignition	Temperature (North End)	Temperature (Middle)	Temperature (South End)
0 minutes	922	944	874
5 minutes	1047	973	1025
10 minutes	1002	1092	993
15 minutes	937	847	987
20 minutes	1177	982	942
25 minutes	1062	1073	1058
30 minutes	898	1162	968
35 minutes	525	460	484
40 minutes	318	362	294