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

October 29, 2015

Ms. Tanya Sloma
Licensing, Compliance and Package Technology
Nuclear Fuel Transport
Westinghouse Electric Company, LLC
5801 Bluff Road
Hopkins, SC 29061

SUBJECT: REVISION NO. 8 OF CERTIFICATE OF COMPLIANCE NO. 9297 FOR THE MODEL NOS. TRAVELLER STD, TRAVELLER XL, AND TRAVELLER VVER PACKAGES (TAC NO. L25014)

Dear Ms. Sloma:

As requested by your application dated May 1, 2015, and as supplemented May 28, August 19, October 9, and October 26, 2015, enclosed is Certificate of Compliance No. 9297, Revision No. 8, for the Model Nos. Traveller STD, Traveller XL, and Traveller VVER packages. Changes made to the certificate are indicated by vertical lines in the margin. The staff's safety evaluation report is enclosed.

The approval constitutes authority to use the package for shipment of unirradiated fissile material and for the package to be shipped in accordance with the provisions of 49 CFR 173.471. Those on the attached list have been registered as users of the package under the general license provisions of 10 CFR 71.17 or 49 CFR 173.471.

If you have any questions regarding this certificate, please contact me or John Vera of my staff at (301) 415-5790.

Sincerely,

/RA/ B. White acting for
Michele Sampson, Chief
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9297
TAC Nos. L25014

Enclosures:
1. Certificate of Compliance No. 9297, Rev. No. 8
2. Safety Evaluation Report
3. Registered Users

Upon removal of Enclosure 3, this document is uncontrolled

cc w/encls 1 & 2: R. Boyle, Department of Transportation
J. Shuler, Department of Energy, c/o L. F. Gelder
Registered Users

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SAFETY EVALUATION REPORT
Docket No. 71-9297
Model Nos. Traveller STD, Traveller XL and Traveller VVER
Certificate of Compliance No. 9297
Revision No. 8

SUMMARY

By application dated May 1, 2015, as supplemented May 28, August 19, October 9, and October 26, 2015, Westinghouse Electric Company, LLC (Westinghouse or the applicant) requested an amendment to Certificate of Compliance (CoC) No. 9297 for the Model Nos. Traveller STD and Traveller XL packages. Westinghouse requested to amend the certificate to add new VVER fuel assembly contents in a new Traveller VVER package design.

Additionally, Westinghouse requested the package review include consideration of NUREG-1886, "Joint Canada – United States Guide for Approval of Type B(U) and Fissile Material Transportation Packages."

NRC staff reviewed the amendment application using the guidance in NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material," and NUREG-1886 "Joint Canada - United States Guide for Approval of Type B(U) and Fissile Material Transportation Packages." Based on the statements and representation in the application, as supplemented, and the conditions listed below, the staff finds that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71. Staff reviewed the application against NUREG-1886, and finds the highlighted areas of emphasis have been appropriately addressed.

EVALUATION

By application dated May 1, 2015, and as supplemented May 28 and August 19, 2015 Westinghouse Electric Company, LLC (Westinghouse or the applicant) requested an amendment to Certificate of Compliance (CoC) No. 9297 for the Model Nos. Traveller STD and Traveller XL packages. Westinghouse requested to amend the certificate to add new VVER fuel assembly contents in a new Traveller VVER package design.

1.0 GENERAL INFORMATION REVIEW

The objective of this review is to verify that the package design has been described in sufficient detail to provide an adequate basis for its evaluation.

1.1 Purpose of application

As stated in the applicant's cover letter, the purpose of the application is to amend the certificate of compliance to include a new Traveller VVER package design to transport VVER fuel assembly contents. In addition, the applicant requested the application be reviewed for the Joint United States – Canada process for package approval and validation, in accordance with NUREG-1886 "Joint Canada–United States Guide for Approval of Type B(U) and Fissile Material Transportation Packages."

1.2 Summary Information and Package Description

This amendment request applies to the previously-approved Certificate of Compliance USA/9297/AF-96. The application states Westinghouse has an NRC-approved quality assurance program. Overall dimensions and maximum weights are provided in the SAR. The containment boundary for the package continues to be the fuel rod. The staff reviewed the application and finds it includes a description of the new packaging design features in sufficient detail to provide an adequate basis for evaluation. The staff finds that the application includes a description of the new contents in sufficient detail to provide an adequate basis for evaluation of the packaging design.

1.3 General Requirements

No changes to the minimum dimension of the package or the tamper-indicating feature are requested, therefore, the package continues to meet general requirements of 10 CFR 71.43.

1.4 Drawings

The application, as supplemented, contained new and revised package drawings. Staff reviewed the revised and new drawings and finds that the information provided therein is sufficiently detailed and consistent with the package description.

2.0 STRUCTURAL AND MATERIALS REVIEW

The objective of the structural review is to verify that the structural performance of the Traveller VVER package meets the regulatory requirements of 10 CFR Part 71.

2.1 Description of Structural Design

The Traveller is a shipping package designed to transport non-irradiated uranium fuel assemblies or rods with enrichments up to 5.0 weight percent. It will carry several types of PWR fuel assemblies, VVER fuel assemblies, as well as either BWR or PWR rods. It is designed to protect the radioactive material from both normal conditions of transport (NCT) and hypothetical accident conditions (HAC) as required by 10 CFR Part 71.

There are three types of package in the Traveller family, which are: (1) Traveller Standard (Traveller STD), (2) Traveller XL, and (3) Traveller VVER. The staff previously reviewed the structural designs of the Traveller STD and XL packages under NCT and HAC, and issued a safety evaluation report on March 15, 2005 (ADAMS Accession No. ML 050750168). The proposed package, Traveller VVER, is also designed to protect the radioactive material from both NCT and HAC as required by 10 CFR Part 71.

The Traveller shipping package consists of two major fabricated components: (1) an outerpack assembly, and (2) a clamshell assembly. The Traveller VVER outerpack is identical to the Traveller XL outerpack except that the shock mounts on the VVER are slightly smaller and stiffer. The Traveller VVER clamshell is similar in build to the Traveller STD and XL clamshell except that the Traveller VVER has been designed for the transport of hexagonal fuel assemblies. The Traveller VVER package is functionally similar to the Traveller STD and XL packages. More detailed information regarding the structural design aspects of the Traveller STD, XL and VVER packages is provided in Chapter 2 of the safety analysis report (SAR).

2.2 Structural Evaluation

The applicant performed supporting structural analyses to demonstrate structural design adequacy of the Traveller VVER package under both NCT and HAC as required by 10 CFR Part 71. The results of these analyses were compared to the previously performed analyses used for licensing of the Traveller XL model. The Traveller XL model is considered as the bounding structural analysis for the Traveller package. The reasons for taking the Traveller XL as bounding analysis were: (1) the structural evaluations of the Traveller STD and XL packages were performed with various tests and computer simulations using a finite element analysis technique, (2) the Traveller VVER package utilizes the same outerpack as the Traveller XL package, (3) the Traveller XL package structurally and mechanically bounds the Traveller VVER and STD packages because the XL is more massive than either the VVER or STD, (4) the Traveller VVER package was also analyzed using the same finite element analysis technique that was used for the recent design changes of Traveller XL, and (5) the numerical analyses and full-scale testing of the Traveller XL units demonstrated a robust design with considerable safety margins with respect to all structural and mechanical requirements, where all tests and structural analyses were previously reviewed and accepted by the staff.

The staff revisited the previous safety findings of the Traveller XL package, and applied them to the structural design aspects of the Traveller VVER package, and found that there is no structural concern under NCT and HAC as required by 10 CFR Part 71. The staff compared the results of the analyses for Traveller VVER with the results of the analyses for Traveller XL, and found that they were bounded and by the results obtained for the Traveller XL and therefore acceptable.

2.3 Materials Evaluation

The following is an evaluation of the materials used in the addition of Model Traveller VVER packaging with VVER fuel assembly contents. The Traveller package is designed to carry one fuel assembly or one pipe for loose rods. All Traveller package models consist of three components, an Outerpack, a Clamshell and a Fuel Assembly or Rod Pipe. All three models are fabricated from similar structural and non-structural materials discussed as follows.

OUTERPACK:

The Outerpack shell is fabricated from American Society of Testing and Materials (ASTM) A240 or A276 Type 304 stainless steel, and is filled with three different densities of closed-cell polyurethane foam, 6 pounds per cubic foot (pcf), 10 pcf, and 20 pcf. The mechanical and thermal properties of the 304 stainless steel have been checked against the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Section II, Part D and found to be acceptable. The foam crush strength was provided as a function of temperature and strain for all three foam densities and found to be in agreement with publicly available data for similar closed-cell polyurethane foams. The foam thermal properties were also checked and found to be in agreement with publicly available data for similar closed-cell polyurethane foams.

A weather gasket is used between the upper and lower portions of the outerpack to prevent rain and water spray from entering the Traveller. The weather gasket is made of either fiberglass or silicone rubber. These seals have no structural or thermal function. The melting temperatures of the weather gasket materials have been checked against publicly available data and found to be acceptable.

Neutron moderation is ensured by the Ultra High Molecular Weight (UHMW) polyethylene (PE) attached to the upper and lower sections of the outerpack. The shock mounts that link the outerpack with the clamshell have a negligible moderating effect. No credit is taken for the polyurethane foam due to the fact that an unknown amount of foam burns away in the fire testing. The density, melt temperature, and thermal properties of the UHMW PE blocks provided have been checked against publicly available data and found to be acceptable. In addition, to aid in protecting the UHMW PE moderator blocks from thermal damage during a fire accident, refractory fiber felt insulation may be used to wrap certain portions of the moderator blocks. The density, melt temperature, conductivity, and specific heat of the insulation provided have been checked against publicly available data and found to be acceptable.

CLAMSHELL:

The VVER clamshell has a hexagonal design as opposed to the standard rectangular clamshell design. The clamshell components and the top plate are fabricated from ASTM B221 or ASTM B209 aluminum alloy 6005-T5 or 6061-T6. These alloys are very similar in chemical composition, and have very similar mechanical and thermal properties. Alloy 6005 is a medium strength alloy that contains higher amounts of silicon. Cork rubber pads protect the contents in NCT, and restrain lateral movement, but serve no structural function. Further, Type 304 stainless steel fasteners are used to attach various clamshell components. The mechanical and thermal properties of ASTM B221 or ASTM B209 aluminum alloy 6005-T5, 6005A-T61, and 6061-T6 have been checked against the ASME B&PV Code Section II, Part D and found to be acceptable.

BORAL PLATES:

Borated 1100 series aluminum plates serve as a thermal neutron absorber for criticality control. Only 75% of the maximum density per unit area of boron-10 that can be achieved in BORAL is credited for conservatism. The staff finds that BORAL is acceptable for use in the Traveller package. In addition, the melting point of 1100 series aluminum used for the BORAL is high enough to preclude melting from occurring during HAC.

CHEMICAL, GALVANIC AND OTHER REACTIONS:

The Traveller materials consist mainly of Type 304 stainless steel, polyurethane foam, ceramic felt insulation, UHMW polyethylene, and 6000 and 1000 series aluminum. No chemical interactions are expected between the metallic and the non-metallic materials in the Traveller package. The outerpack and clamshell are fabricated from dissimilar metals, however the clamshell is held away from the outerpack with rubber pads, thus they are not in contact and no galvanic reactions are expected under normal operations. The fasteners in the clamshell are in contact with aluminum, and the galvanic potential difference between these two dissimilar metals is too high to completely preclude any galvanic interaction, but the surface of the aluminum is much greater than that of the fasteners. As a result, the cathode-to-anode ratio is very small, and significant degradation of the aluminum will be precluded. The outerpack, Type 304 stainless steel, or the clamshell, aluminum (physically isolated inside the outerpack), will not undergo any measurable chemical or galvanic reaction with air or water that will adversely affect the Traveller package. The staff finds that during normal operation the Traveller internals will not be subject to continuous or frequent exposure to moisture and that any water intrusion is not likely to occur in abundant quantities. Further, visual inspections to be performed of the payload cavity during offloading and at other various timed intervals provide reasonable assurance against any considerable corrosion occurring unnoticed.

EFFECTS OF RADIATION ON MATERIALS:

Radiation levels under normal handling and transport conditions are negligible for the Traveller package, thus no materials in the Traveller will be adversely affected by radiation.

BRITTLE FRACTURE:

The staff finds that all structural components of the Traveller package are fabricated of austenitic stainless steel and/or face-centered-cubic (FCC) materials. These materials will not undergo a severe ductile-to-brittle transition in the temperature range of interest (i.e., down to -40°C) and thus does not need to be evaluated for brittle fracture. Therefore, brittle fracture is not a failure mode of concern. In general, as temperature is reduced, the strength and hardness of metals increase, the magnitude depends on the material. However, ductility may or may not decrease noticeably. Metals having a FCC structure, such as austenitic stainless steel, and aluminum, remain tough and ductile to very low temperatures whereas metals possessing a body centered cubic structure (iron/structural steel) undergo a marked decrease in ductility in some temperature range which varies with the material and conditions. Austenitic stainless steel can be considered suitable for sub-zero (ambient) temperatures and locations (typically down to -40°C) resulting from the FCC atomic structure a consequence of the nickel addition to these steels. Austenitic SS does not exhibit an impact ductile/brittle transition, but a progressive reduction in Charpy impact values as the temperature is lowered.

2.4 Structural and Material Evaluation Findings

On the basis of the review of the applicant's statements and representations in the SAR, the review of the methodology and calculations, and the review of the technical conclusions presented by the applicant, the staff finds that the Traveller VVER package meets the regulatory requirements of 10 CFR Part 71 regarding structural performance.

The staff finds that the Traveller transportation package is composed of materials that prevent galvanic or chemical reactions, can tolerate subzero temperatures without undesirable metallurgical consequences, and is constructed with materials and processes in accordance with acceptable industry codes and standards, therefore it meets the regulatory requirements of 10 CFR Part 71 regarding materials.

3.0 THERMAL REVIEW

3.1 Thermal Evaluation

The Traveller VVER is functionally similar to the Traveller and Traveller XL packages in that it utilizes the same transportation outerpack and contains an inner clamshell which secures a fuel assembly. Materials of construction which include various thermal properties are presented in the SAR. The primary difference between the VVER and the XL is the physical shape of the fuel assembly which requires a hexagonal clamshell for the VVER, rather than a rectangular clamshell used for the XL. The thermal review of the Traveller VVER ensures that material temperature limits of the package and associated materials are not exceeded.

The applicant's methodology to demonstrate regulatory compliance was to demonstrate thermal similarity between the XL and VVER and demonstrate that the approach used for the XL is adequate for the VVER. This was achieved by analyzing the VVER using the thermal model developed for the XL with appropriate thermal parameters for the VVER fuel assembly. The results of the thermal analysis demonstrated that the overall temperatures experienced by the

VVER were within the same range as for the XL, therefore the applicant concluded that the overall VVER thermal response is similar to the overall thermal response for the XL. Because of this similarity, the Traveller XL can be considered the bounding case with respect to thermal performance including NCT and HAC. Based on a review of the materials of construction and the analysis approach and associated results, the NRC staff finds this approach acceptable for this amendment request.

The previous safety findings by the NRC for the Traveller XL noted that there was no thermal concern for NCT. For HAC, the NRC staff focused their evaluation on the polyethylene moderator and found that after the regulatory fire, the moderator was still able to perform its functions. Based on the similarity argument, the NRC staff finds that this would also be the case for the VVER configuration.

3.2 Thermal Evaluation Findings

Based on the information presented in the application, review of the methodology and calculations, and review of the technical conclusions presented by the applicant, the staff finds that the Traveller VVER packaging can safely transport the fresh fuel contents in accordance with the requirements of 10 CFR Part 71.

5.0 SHIELDING REVIEW

5.1 Shielding Evaluation

The purpose of the shielding review is to verify that the package design meets the external radiation requirements of 10 CFR Part 71. As stated in the application, the Traveller packaging is designed to transport unirradiated uranium dioxide fuel in the form of either a fuel assembly or as loose fuel rods in a rod pipe. The maximum enrichment for this unirradiated fuel is 5.0 weight percent of uranium-235. The forms of radiation that are associated with low enriched unirradiated uranium are alpha, beta, and gamma radiation. These forms of radiation are the result of radioactive decay of the uranium isotopes and their daughter products. Alpha and beta radiation emitted by these isotopes are easily shielded by the Traveller packaging material. The gamma radiation associated with these isotopes has a very low energy gamma (maximum energy less than 200 keV). Both uranium-238 and uranium-235 have extremely long half-lives (the shorter being on the order of 7×10^8 years), which means the activity is extremely low and these isotopes are relatively stable. This is why the A_2 value (maximum amount of radioactive material permitted in a Type A package per Table A-1 of Appendix A of 10 CFR Part 71) for uranium enriched below 20% is unlimited. Therefore the staff has reasonable assurance that the package will meet all NCT and HAC external dose rate limits within 10 CFR 71.47 and 10 CFR 71.51(a)(2).

5.2 Shielding Evaluation Findings

Based on the information submitted in the application, the staff has reasonable assurance that the shielding design meets the external radiation standards in 10 CFR Part 71.

6.0 CRITICALITY REVIEW

6.1 Criticality Evaluation

The applicant requested to amend the certificate of compliance to include VVER fuel assembly contents in the Traveller VVER package. The current Traveller shipping package is approved to carry a single PWR fuel assembly or a single rod container that holds either PWR or BWR rods.

6.2 Criticality Design Criteria and Features

Changes to the design criteria include a hexagonal clamshell, with neutron absorbing Boral® plates installed along six sides, enclosing a hexagonal VVER assembly. The outerpack is similar to the previously approved design but with shock mounts modified to accommodate the hexagonal clamshell. Polyurethane foam material is encased by the package outerpack. Neutron moderating high-density polyethylene blocks are fastened to the upper and lower halves of the outerpack, making the neutron absorber more effective in array configurations.

6.3 Fuel Specification

The applicant specified that the fuel material to be used for the VVER fuel assemblies is identical to the fuel material for the previously approved contents (uranium dioxide pellets sealed in zirconium alloy cladding). The uranium enrichment shall not be greater than 5.0 weight percent ^{235}U.

6.4 Model Specification

The applicant used a modeling approach for the new VVER fuel assembly that is similar to the one previously used for the other fuel assembly contents. This methodology continues to be acceptable to staff. The applicant used three-dimensional calculation models for its criticality analyses.

6.5 Criticality Evaluation Summary

The applicant demonstrated that the VVER contents remained subcritical under NCT and HAC, for single packages and arrays of packages. An unknown amount of polyurethane foam burns away in the fire testing and therefore is not credited in the criticality analysis under accident conditions. The ultra-high molecular weight polyethylene moderator blocks are modeled at 90% actual density. The shock mounts are not credited and modeled as void. The analysis provided in the SAR supports a CSI of 0.7. The results of the staff's independent analysis confirmed the applicant's results.

6.6 Computer Programs

The applicant performed calculations using the KENO-VI three-dimensional Monte Carlo transport code in the SCALE 5.1 code package, with the 238-group ENDF/B-VI library. The staff requested examples of the applicant's KENO-VI input files in order to confirm their VVER model and calculation results.

The applicant validated their calculation method against 37 critical experiments based on materials, neutrons poisons, geometry, and neutron energy similar to the VVER design. Using the same code and cross section library, the applicant calculated an upper safety limit (USL) of 0.9350.

NRC staff performed confirmatory calculations using the CSAS6 sequence of the SCALE 6.1 code system, with the KENO VI three-dimensional Monte Carlo transport code and a continuous-energy cross section library. The applicant's supplied SCALE 5.1 input files were changed to be compatible with SCALE 6.1, and modified to use the continuous-energy ENDF/B-VII.0 library. NRC staff results confirmed the applicant's results.

6.7 Criticality Evaluation Findings

Based on review of the statements and representations in the application, the staff concludes with reasonable assurance that the nuclear criticality safety design has been adequately described and evaluated and that the package meets the subcriticality requirements of 10 CFR Part 71.

CONDITIONS

The following changes have been made to the certificate:

Condition No. 5(a)(1) has been modified to add the Traveller VVER model.

Condition No. 5(a)(2) has been modified to include the Traveller VVER description, weights, and dimensions.

Condition No. 5(a)(3) has been modified to add Drawing No. 10037E43, Rev. 3 (sheets 1-8), and insert Drawing 10004E58, Rev. 9 (sheets 1-9) which replaces Rev. 8.

Condition No. 5(b)(1) has been modified to specify it refers to PWR Fuel Assembly types.

Condition No. 5(b)(2) has been modified to specify the correct Traveller models to be used to transport loose fuel rods.

Condition No. 5(b)(3) has been created to specify the VVER fuel contents and parameters.

Condition No. 9 was revised to authorize use of Revision No. 7 of the CoC until October 31, 2017.

The references section has been updated to list the consolidated application and supplements.

CONCLUSION

Based on the statements and representations contained in the application, as supplemented, and the conditions listed above, the staff concludes that the design has been adequately described and evaluated, and the Model Nos. Traveller STD, Traveller XL, and Traveller VVER packages meet the requirements of 10 CFR Part 71 and the guidance on format and content in NUREG-1886 for joint approval in Canada.

Issued with Certificate of Compliance No. 9297, Revision No. 8.