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

July 9, 2014

Mr. Robert E. Link
AREVA Inc.
Environmental, Health, Safety & Licensing
2101 Horn Rapids Rd.
Richland, WA 99354

SUBJECT: AUTHORIZATION FOR SHIPMENT OF THE MODEL NO. TN-B1 PACKAGE WITH ATRIUM 11 LEAD TEST ASSEMBLIES

Dear Mr. Link:

As requested by your letter dated March 3, 2014, pursuant to Title 10 of the *Code of Federal Regulations* Part 71, the Certificate of Compliance (CoC) No. 9372 for the Model No. TN-B1 package is amended to allow ATRIUM 11 lead test assemblies, which are not already authorized contents in the CoC, to be shipped. All other conditions of CoC No. 9372 shall remain the same. This authorization is valid for one shipping campaign for packages to be shipped between December 1, 2014, and January 31, 2015, and is limited by the following conditions:

1. There will be a single ATRIUM 11 fuel assembly per container.
2. The other side of the container will contain either a fuel channel, cage assembly with tie plates, or ballast having the same peripheral envelope. This side of the container will contain no fissile material.
3. The single fuel assembly will be unchanneled.
4. The fuel assemblies will contain UO_2 and Gd_2O_3 only.
5. There will be a maximum of eight TN-B1 packages on a single truck.
6. A maximum of eight fuel assemblies will be included in any shipment.

If you have any questions regarding this authorization, please contact me or Huda Akhavannik at (301) 287-9241.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

/RA/

Timothy Lupold, Acting Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9372
TAC No. L24902

Enclosure: Safety Evaluation Report

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OFFICIAL AGENCY RECORD

UNITED STATES
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SAFETY EVALUATION REPORT
Docket No. 71-9372
Model No. TN-B1
Certificate of Compliance No. 9372

SUMMARY

By application dated March 3, 2014, AREVA Inc. (the applicant) requested a one-time authorization to ship Model No. TN-B1 packages containing ATRIUM 11 lead test assemblies which are not an authorized content in Certificate of Compliance (CoC) No. 9372.

A one-time letter authorization has been granted to authorize these shipments based on the statements and representations in the application. The staff agrees that the change does not affect the ability of the package to meet the requirements of 10 CFR Part 71.

EVALUATION

By application dated March 3, 2014, the applicant requested a one-time authorization to ship Model No. TN-B1 packages containing ATRIUM 11 lead test assemblies (LTA) which are not an authorized content in CoC No. 9372, Rev. 0. Except for administrative changes, CoC No. 9372, Rev. 0, is identical to the currently approved Model No. RAJ-II transportation package, CoC No. 9309, Rev. 9, and uses the same analyses. As such, the analyses performed for this letter authorization take their basis from the analyses performed as part of the Model No. RAJ-II approval.

The TN-B1 is capable of shipping two fuel assemblies in a single package; however, in these shipping campaigns, only one unchanneled assembly containing uranium oxide (UO_2) and gadolinium oxide (Gd_2O_3) will be shipped per package. The other side of the container will contain no fissile material and must contain either: a fuel channel, cage assembly with tie plates, or ballast having the same peripheral envelope as the fuel assembly. There will be a maximum of eight TN-B1 packages on a single truck with a maximum of eight fuel assemblies in any shipment. Based on its review, the staff determined that the request does not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Structural

Staff reviewed the results (as presented in “Design Analysis and Calculation No. NSA-DAC-AREVA-14-01,” Rev. 0) of the structural analyses of the ATRIUM 11 LTA in the Model No. TN-B1, during normal conditions of transport (NCT) of 10 CFR 71.71 and hypothetical accident Conditions (HAC) of 10 CFR 71.73. Staff also reviewed the impact of shipping fuel assemblies with reduced weight in the TN-B1 container. The HAC analyses for a 30-ft drop was simulated by the LSDYNA finite element dynamic simulation program, with a conservative scaled-up acceleration time history (ATH). The peak values of ATH taken from the instrumented results recorded in the actual drop tests performed by the Japan Nuclear Fuel Co. were amplified with a scale factor to achieve minimum factor of safety of 1.4 for the (plastic) structural stability as required by ASME, B and PV Code, 2010, Section III, Appendix F, Section F-1341.4.

Staff finds that the structural analyses as presented in the above mentioned report, including Appendices A and B, demonstrate that the un-channeled ATRIUM 11 LTA packaged in the Model No. TN-B1, with a single element in each shipping container and a ballast in the other container, meets the regulations of 10 CFR Part 71, without any gross deformations.

Materials

The staff conducted a materials review for the proposed ATRIUM 11 LTA shipment. Staff reviewed the requirements dealing with the compatibility of the materials, the ability of the materials to perform without generating gases or corrosive atmospheres due to corrosion or radiolysis, and the ability of the materials to meet the temperature requirements. The ATRIUM 11 LTA does not contain pyrophoric, flammable, or explosive components. Additionally, staff reviewed the material properties used for the analysis presented in “Design Analysis and Calculation No. NSA-DAC-AREVA-14-01,” Rev. 0. The review found inconsistencies in the referenced documents in this report. Specifically, the elastic modulus of Zircaloy-2 at -40°C was derived using a model only valid from 20 to 400°C. This model was obtained from a conference proceeding, and its validity might have not been peer-reviewed. However, staff determined that the derived value is consistent with NUREG/CR-6150, “SCDAP/RELAP5/MOD 3.3 Code Manual,” and its use should not significantly alter the calculated safety factor. The staff also found incorrect referencing of the Zircaloy-2 Poisson’s ratio and unclear justification for the assumed constant value in the analysis. However, staff determined that the value is consistent with NUREG/CR-6150 and its use should not significantly alter the calculated safety factor.

The staff concludes that reasonable assurance was provided that the proposed one-time shipment, subject to the conditions in this letter, meets the regulatory requirements for NCT and HAC per 10 CFR Part 71.

Thermal

Staff reviewed the thermal sections found in the NCT and HAC sections of “Design Analysis and Calculation No. NSA-DAC-AREVA-14-01,” Rev. 0.

<u>NCT</u>

The applicant provided calculations to determine the nominal diametral clearance at room temperature between the outer diameter of the fuel and the inner diameter of the cladding. In addition, the applicant provided the thermal expansion tables for the cold condition temperature of -40°C (233 K) and the hot condition temperature of 77°C (350 K), which led to the net diametral clearance of 0.0060 inches during the cold condition and 0.0058 inches during the hot condition.

The staff reviewed the methods used by the applicant, and calculations provided by the applicant to determine the nominal diametral clearance, and performed confirmatory calculations to validate the equations used and values that were calculated. Based on the staff’s review, the staff finds reasonable assurance that the regulations for hot and cold conditions, 10 CFR 71.71(c)(2) and 10 CFR 71.71(d)(3)(1), were met.

The maximum pressure (113.1 psia) during NCT was calculated using the ideal gas law at 77°C and the pressure resulting from helium pressurization during fuel rod fabrication. The value for the applied pressure on the inside of the fuel rods was calculated by subtracting the value for atmospheric pressure, 14.7 psi. The thermal stress (specifically tangential stress equal to 813 psi) was calculated using the applied pressure load on the inside of fuel rods, cladding outside radius, and the cladding radial thickness.

The staff reviewed the calculations provided by the applicant on maximum pressure and thermal stress and reviewed the methods used by the applicant. In addition, staff performed confirmatory calculations to validate the equations used and values that were calculated. Based on the staff's review, the staff finds reasonable assurance that the regulations for NCT were met.

HAC

The applicant provided calculations to determine the nominal diametral clearance at room temperature between the outer diameter of the fuel and the inner diameter of the temperature. In addition, the applicant provided a thermal expansion table for the accident condition temperature of 800°C (1073 K), which led to the net diametral clearance of 0.0060 inches during the cold condition and 0.0052 inches during the accident condition.

The staff reviewed the methods used by the applicant, calculations provided by the applicant, and performed confirmatory calculations to validate the equations used and values that were calculated. Based on the staff's review, the staff finds reasonable assurance that the regulations for the hot accident condition that is specified in 10 CFR 71.73(d)(4) was met.

Maximum pressure (346.8 psia) during HAC was calculated using the ideal gas law at 800°C and the pressure resulting from helium pressurization during fuel rod fabrication. The value for the applied pressure on the inside of the fuel rods was calculated by subtracting the value for atmospheric pressure, 14.7 psi. Thermal stress (specifically tangential stress equal to 2738 psi) was calculated using the applied pressure load on the inside of fuel rods, cladding outside radius, and the cladding radial thickness. In addition, from RAJ-II SAR, Rev. 7, referenced in the letter of authorization, the applicant also demonstrated through testing that the fuel rods with similar cladding material can withstand the temperature mentioned in 10 CFR 71.73(d)(4) for more than 60 minutes without failure. The maximum pressure calculated was 592.2 psia, which led to an applied load of 577.5 psi and the corresponding tangential stress of 4510 psi for the stress that is taking place inside of the fuel rods. From these analyses, a factor of safety of 1.65 was calculated, which shows significant margin against potential failure.

The staff reviewed the calculations provided by the applicant on maximum pressure and thermal stress and reviewed the methods used by the applicant. In addition, staff performed confirmatory calculations to validate the equations used and values that were calculated. Based on the staff's review, the staff finds reasonable assurance that the regulations for HAC are met.

Criticality

Staff reviewed the criticality evaluation presented in AREVA Inc., Document FS1-0014030, Revision 2, "TN-B1 Criticality Safety Analysis for ATRIUM 11 Lead Assemblies." The applicant evaluated the Model No. TN-B1 package containing a single unchanneled ATRIUM 11 fresh UO_2 fuel assembly, with a fuel channel, cage assembly with tie plates, or ballast having the same peripheral envelope as the fuel assembly in the other inner container channel. The fuel assembly consists of 92 full-length rods, 8 long part-length rods, and 12 short part-length rods, with a 3 rod by 3 rod central water channel. Gd_2O_3 may be present in the fuel material, but is not credited in the criticality analysis.

The applicant evaluated single packages and arrays of packages under NCT and HAC. The applicant evaluated an array of 25 packages under NCT, and 9 packages considering the effects of HAC.

For the package under NCT, the applicant conservatively considered in-leakage of water into the inner container. The single package model considered full density water in the outer packaging, and varying water density in the inner container. The array model considered water density variation within both the inner and outer containers. The maximum keff + 2σ was 0.6404 for the single package, and 0.7110 for the array of 25 packages with full density water in the inner container, and void in the outer container.

For the package under HAC, the applicant considered reduced external dimensions of the outer packaging from the drop and puncture tests, which allows closer spacing of the inner containers in an array of packages. This model included variation in inner container and outer container water density, and determined the moderating effects of melted polyethylene foam material in the inner container. The applicant also considered the effect of eccentric positioning of the fuel assembly within the inner container, and the worst-case combination of fuel manufacturing tolerances. Additionally, the applicant considered the potential for uniform pitch expansion due to a top or bottom end drop. The expanded pitch model included a 15% pitch expansion over the entire length of the assembly, bounding the maximum localized pitch expansion resulting from the structural analysis. The maximum keff + 2σ under hypothetical accident conditions was 0.7126 for the single package, and 0.7534 for the array of 9 packages with full density water in the inner container, and void in the outer container.

The applicant used the CSAS25 sequence of the SCALE 4.4a code system, with the 44-group ENDF/B-V cross section library and the KENO V.a three-dimensional Monte Carlo code, for all criticality analyses. The applicant previously performed a benchmarking analysis for this code and cross-section library, and determined an Upper Safety Limit (USL) on keff of 0.94254, which remains applicable for the fuel assembly and package evaluated in this criticality safety analysis. The maximum calculated keff for the Model No. TN-B1 package is significantly below this USL. The bounding criticality safety index (CSI), based on the hypothetical accident conditions array of 9 packages, is 11.2.

The staff performed confirmatory criticality calculations using the SCALE 6.1 code system, with the continuous energy ENDF/B-VII cross section library and the KENO VI three-dimensional Monte Carlo code. Using assumptions similar to the applicant's, the staff confirmed the highest keff values determined by the applicant.

Staff finds that the criticality analyses provided in AREVA Inc., Document FS1-0014030, Revision 2, demonstrate that a single un-channeled AREVA ATRIUM-11 fuel assembly contained in the Model No. TN-B1 package, meets the criticality safety regulations of 10 CFR Part 71, with a CSI of 11.2.

CONDITIONS

CoC No. 9372 has been amended by letter to authorize shipment of packages containing ATRIUM 11 Lead Test Assemblies. The following conditions apply:

1. There will be a single ATRIUM 11 fuel assembly per container.
2. The other side of the container will contain either a fuel channel, cage assembly with tie plates, or ballast having the same peripheral envelope. This side of the container will contain no fissile material.
3. The single fuel assembly will be unchanneled.
4. The fuel assemblies will contain UO_2 and Gd_2O_3 only.
5. There will be a maximum of eight TN-B1 packages on a single truck.
6. A maximum of eight fuel assemblies will be included in any shipment.

All other conditions of CoC No. 9372 shall remain the same. This authorization expires January 31, 2015.

CONCLUSION

CoC No. 9372 has been amended by letter to authorize shipment of Model No. TN-B1 packages containing ATRIUM 11 lead test assemblies. This authorization expires January 31, 2015.

Based on the statements and representations in the application, and with the conditions listed above, the staff agrees that this change does not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued on July 9, 2014.