September 7, 2010

Dr. James Shuler, Manager
Packaging Certification Program
Safety Management and Operations
Office of Environmental Management
U.S. Department of Energy
Washington, DC 20585

SUBJECT: REVISION NO. 2 OF CERTIFICATE OF COMPLIANCE NO. 9330 FOR THE MODEL NO. ATR-FFSC PACKAGE

Dear Dr. Shuler:

As requested by your application dated July 29, 2010, enclosed is Certificate of Compliance No. 9330, Revision No. 2, for the Model No. ATR-FFSC package. Changes made to the enclosed certificate are indicated by vertical lines in the margin. The staff's Safety Evaluation Report is also enclosed.

This 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. 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 Pierre Saverot of my staff at (301) 492-3408.

Sincerely,

**/RA/**

Eric J. Benner, Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9330
TAC No. L24462

Enclosures:
1. Certificate of Compliance No. 9330, Rev. No. 2
2. Safety Evaluation Report
3. Registered Users

cc w/encls. 1& 2: R. Boyle, Department of Transportation
Registered Users

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**Closes TAC No. L24462**

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| **NAME:** | BTripathi | | DJackson | | MDeBose | | EJBenner | | | |
| **DATE:** | 08/31/10 | | 08/31/10 | | 09/02/10 | | 09/07/2010 | | | |

**C = COVER** **E = COVER & ENCLOSURE** **N = NO COPY**

**SAFETY EVALUATION REPORT**
**Model No. ATR FFSC Package**
**Certificate of Compliance No. 9330**
**Revision No. 2**

## SUMMARY

By application dated July 29, 2010, the U.S. Department of Energy submitted an amendment request to add the fresh fuel element of the Rhode Island Nuclear Science Center (RINSC) as authorized content for the Model No. ATR FFSC (Advanced Test Reactor Fresh Fuel Shipping Container) as a Type AF-96 package. The Model No. ATR FFSC package had been previously approved for transportation of a single unirradiated fuel element for the Advanced Test Reactor (ATR), the Massachusetts Institute of Technology (MIT) Research Reactor, and the Missouri University Research Reactor (MURR) or for unirradiated loose ATR fuel plates

The RINSC fuel, an aluminum plate type fuel similar to the MIT fuel type, has a nominal enrichment of 19.4 wt% of U-235 and a maximum enrichment of 19.94 %. Only one fuel element is to be shipped per package. Loose RINSC ATR fuel plates are not an authorized content. The total weight of U-235 is 283 grams per package and the nominal weight of the uranium payload is 1458.8 grams.

The package was evaluated against the regulatory standards in 10 CFR Part 71, including the general standards for all packages, and performance standards for fissile material packages under normal conditions of transport (NCT) and hypothetical accident conditions (HAC). Based on the statements and representations in the application, and the conditions listed below, the staff concluded that the package meets the requirements of 10 CFR Part 71.

## 1.0 GENERAL INFORMATION

The RINSC Model No. ATR FFSC package is designed to contain a single RINSC ATR fuel element in an aluminum fuel handling enclosure (FHE). The package is composed of a six (6) inch (outer diameter) stainless steel cylindrical tube surrounded by one (1) inch thick insulation in an 8 inch x 8 inch stainless steel square tube with 73 inches in length. The wall thickness of the square tube is 3/16 inch. The package closure seats into the end of the packaging and engages the packaging using four lugs in a bayonet-style design. Neoprene is attached to the internal surfaces of the FHE to minimize fretting of the fuel element side plates during transportation. Licensing Drawing No. 60501-60 provides information on the structure, materials, and dimension of the RINSC ATR fuel element handling enclosure. The closure of the packaging does not have any gaskets or seals. There are no neutron poisons in the package. The neoprene materials attached to the side plates provide some limited neutron moderating capability but are not accredited as flux trap.

## 2.0 STRUCTURAL

The applicant requested that RINSC fuel and corresponding FHE be added as approved contents for the ATR-FFSC. The applicant takes no credit for the presence of the FHE for structural integrity purposes and any and all potential damage to the RINSC fuel assembly is accounted for in the criticality evaluation, as verified by staff. Furthermore, the mass of the fuel assembly is bounded by previously approved contents and the general construction arrangement of the FHE is similar in both geometry and materials of construction and is therefore bounded by previously approved evaluations.

## 3.0 THERMAL

The staff reviewed the addition of the RINSC unirradiated fuel element and respective FHE. The package with the RINSC fuel element payload was not thermally modeled; the applicant instead discussed a qualitative thermal analysis in the application. Due to the similarity in total weight of the MURR and RINSC payloads with their respective FHEs, the MURR and RINSC FHEs being fabricated from the same material, and the fuel plates having comparable thermal mass, the applicant states that the maximum NCT and HAC temperatures for the RINSC payload will be bound by the temperatures calculated with the MURR payload in Table Nos. 3.6-5 and 3.6-7 of the application. The staff accepts this qualitative thermal analysis for the RINSC payload along with the large thermal margin.

The staff also reviewed the change from a flame temperature of 1425°F with an emissivity of 1.0 to 1475°F with an emissivity of 1.0. Due to the change, maximum HAC temperatures increased by approximately 50°F for the outside of the package and by approximately 35°F for the each of the three types of analyzed fuel elements (ATR, MIT, and MURR). Other internal components saw temperature increases between 35°F and 50°F. All component temperatures are well within their limits provided in Table No. 3.1-1 of the application. The staff confirmed these temperature increases by changing the boundary conditions in the applicant's models. Due to the outer shell temperature increase, the HAC pressure of the volume between the inner and outer shell increased by less than 1 psig to 39 psig. Based on the staff's review of the thermal sections of the application, the staff finds reasonable assurance that the package meets the thermal standards of 10 CFR Part 71.

## 4.0 CONTAINMENT

Not applicable.

## 5.0 SHIELDING

Not applicable.

## 6.0 CRITICALITY

The applicant provides the results of the criticality safety analyses for a single package and arrays of packages with the RINSC fuel element under NCT and HAC in Section No. 6.11 of the application. Table No. 6.11-1 of the application shows that the calculated maximum $k_{eff}$ values, including two standard deviations, are less than the Upper Subcritical Limit (USL) of 0.9209, including the administrative margin and bias. The applicant conservatively assumes a fuel enrichment of 94 wt% of U-235 and a homogeneous uranium/water mixture and does not include further considerations on tolerances and uncertainties of the fuel enrichment and fuel

element dimensional parameters. The applicant uses a (3x3+1) square pitch array and a 2x2x1 square pitch array of packages for NCT and HAC array calculations, respectively, and studies the $k_{eff}$ of the package as a function of water/uranium height in the package cavity, as reported in Table Nos. 6.11-4 and 6.11-5 of the application. Because the total quantity of uranium is kept the same, varying the height effectively changes the water/uranium ratio. This study, though not directly, identified the maximum reactivity with preferential flooding.

The staff performed independent analyses, for single package and arrays of the RINSC ATR fuel packages under HAC, to confirm both the applicant's results and that the most reactive conditions had been correctly identified. The CSAS26 criticality sequence with the KENO-VI geometry and multi-group cross sections of the SCALE 5.1 system, and the 238-group cross section library derived from ENDF/B-V data, were used in these analyses. The staff also performed search for the optimal H/U ratio to confirm that the applicant has correctly identified the most reactive package configuration.

The use of a separate FHE and the void space between the insulation and outer package wall in the corner areas of the package create the potential for preferential flooding in the package. Under certain circumstances, a preferentially flooded cask may result in a more reactive system. The staff examined the reactivity of the array of partially flooded packages under HAC and the results indicate that partial flooding with a water density of 0.7 grams/cm$^3$ will result in a slightly more reactive system than the one with other water densities (from 0.5 to 1.0 grams/cm$^3$) in the FHE and the void space between the insulation and outer package wall in the corner areas of the package. The difference in reactivity, however, is within the range of the statistical uncertainties of the calculations. The staff created separate models with the actual fuel enrichment and payload to show that the results of the applicant's analyses, using 400 grams and a 94 wt% enrichment of U-235 assumption, are conservative. For the purposes of determining the Criticality Safety Index (CSI), the HAC array is the most limiting. Because the 30-ft drop test results show no significant deformation on the corners along the axial direction of the package, a square-pitch array is adequate for the purpose of calculating the CSI and it is unnecessary to model triangular pitch arrangement of the undamaged or damaged packages. Based on the applicant's analysis and staff's confirmatory calculations, the staff finds that the applicant correctly derived the CSI, and that a CSI of 25.0 is appropriate for the package. Because large safety margins were included in the analysis, no additional parameter limits are found to be necessary to include in the certificate.

## 7.0 PACKAGE OPERATIONS

Not applicable.

## 8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

Not applicable.

The staff reviewed the package application dated July 29, 2010, and determined that the documentation was available and complete. The following changes are included in Revision No. 2 to Certificate of Compliance No.9330:

Item No. 3(b) was modified to identify the latest revision of the package application dated July 29, 2010.

Condition No. 5(a)(2) was modified to include the fuel handling enclosure for the RINSC fuel element.

Condition No. 5(a)(3) was modified to reference Drawing No 60501-60, Rev. 0, for the RINSC fuel handling enclosure

Condition No. 5(b)(1) was modified to (i) clarify the maximum local spacing gap between plates and specify that the maximum channel thickness between ATR fuel place is 0.087 inch in localized areas, and (ii) include the RINSC fuel element as authorized contents in the package.

Condition No. 5(b)(2) was modified to indicate a maximum quantity of one RINSC fuel element per package.

Condition No. 5(c) was modified to include a CSI of 25 for a package containing one RINSC fuel element. The CSI of 4 for a package containing ATR, MURR, MIT fuel elements or ATR fuel plates remains unchanged.

Condition No. 10 allows the previous revision of the certificate to be used for a period of approximately one year.

The expiration date of the certificate was not changed. The References section was modified to include the application dated July 29, 2010.

**CONCLUSION**

Based on the statements and representations contained in the application, and the conditions listed above, the staff concluded that the Model No. ATR FFSC package meets the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9330, Revision No.2
on September 7, 2010.