November 30, 2004

Mr. Charles M. Vaughan
Manager
Global Nuclear Fuel - Americas, LLC
Castle Hayne Road
Wilmington, NC 28401

SUBJECT: CERTIFICATE OF COMPLIANCE NO. 9309 FOR THE MODEL NO. RAJ-II PACKAGE

Dear Mr. Vaughan:

As requested by your application dated March 31, 2004, as supplemented April 22, 2004, September 3 and 16, 2004, October 28, 2004, November 8 and 29, 2004, enclosed is Certificate of Compliance No. 9309, Revision No. 0, for the Model No. RAJ-II package. The staff's Safety Evaluation Report is also enclosed.

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. 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 or Shawn Williams of my staff at (301) 415-8500.

Sincerely,
/RA/

John Monninger, Chief
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9309
TAC No. L23727

Enclosures:
1. CoC. No. 9309, Rev. 0
2. Safety Evaluation Report

cc w/encl: R. Boyle, Department of Transportation
James M. Shuler, Department of Energy
RAMCERTS
Registered Users

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SAFETY EVALUATION REPORT
Docket No. 71-9309
Model No. RAJ-II Package
Certificate of Compliance No. 9309
Revision No. 0

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SAFETY EVALUATION REPORT
Docket No. 71-9309
Model No. RAJ-II Package
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SUMMARY

By application dated March 31, 2004, as supplemented April 22, 2004, September 3 and 16, 2004, October 28, 2004, November 8 and 29, 2004, Global Nuclear Fuel - Americas, LLC (GNF) requested that the Nuclear Regulatory Commission (NRC) approve the Model No. RAJ-II package containing both Type A and Type B fissile material in the form of Boiling Water Reactor (BWR) fuel assemblies or individual fuel rods.

The package consists of an inner and outer container each fabricated with stainless steel and separated by cushioning material. The package is approximately 5,068 mm long, 720 mm wide, and 742 mm high. The maximum gross shipping weight of the package is 3,558 lbs.

The package was evaluated against the regulatory standards in 10 CFR Part 71, including the general standards for all packages, standards for fissile material packages, and performance standards under normal conditions of transport (NCT) and hypothetical accident conditions (HAC). The applicant demonstrated the structural integrity of the package by subjecting prototype packages to the NCT and HAC tests described in the regulations. The tests showed that for normal and accident conditions the package remained securely closed and the fuel assemblies remained unaffected.

The applicant performed criticality analyses for various types of fuel assemblies. The analyses showed that the fuel would remain subcritical under NCT. The analyses for HAC considered the damage that was observed in the prototype packages that were subjected to the physical tests.

NRC staff reviewed the application using the guidance in NUREG 1609, "Standard Review Plan for Transportation Packages for Radioactive Material." Based on the statements and representations in the application, as supplemented, and the conditions listed below, the staff concluded that the package meets the requirements of 10 CFR Part 71.

REFERENCES

Global Nuclear Fuel - Americas, LLC, application dated March 31, 2004.

Supplements dated April 22, 2004, September 3 and 16, 2004, October 28, 2004, November 8 and 29, 2004.

1.0 GENERAL INFORMATION

1.1 Package

The RAJ-II package is a rectangular box that is 742 mm (29.21 in) high by 720 mm (28.35 in) wide by 5,068 mm (199.53 in) long to transport a maximum of two Boiling Water Reactor (BWR) fuel assemblies or individual rods that meet the ASTM C996-96 standard of enriched commercial grade uranium or enriched reprocessed uranium.

It is comprised of one inner container and one outer container both made of stainless steel. The inner container is comprised of a double-wall stainless steel sheet structure with alumina silicate thermal insulator filling the gap between the two walls to reduce the flow of the heat into the contents in the event of a fire. Foam polyethylene cushioning material is placed on the inside of the inner container for protection of the fuel assembly. The outer container is comprised of a stainless steel angular framework covered with stainless steel plates. Inner container clamps are installed inside the outer container with a vibro-isolating device between to alleviate vibration occurring during transportation. Wood and honeycomb resin impregnated kraft paper are placed as shock absorbers to reduce shock in the event of a drop of the package. The fuel rod clad and ceramic nature of the fuel pellets provide primary containment of the radioactive material.

The approximate dimensions and weights of the package are as follows:

Maximum gross shipping weight	1,614 kg (3,558 lbs)
Maximum weight of inner container	308 kg (679 lbs)
Maximum weight of outer container	622 kg (1,371 lbs)
Maximum weight of packaging	930 kg (2,050 lbs)
Dimensions of inner container	
Length	4,686 mm (184.49 in)
Width	459 mm (18.07 in)
Height	286 mm (11.26 in)
Dimensions of outer container	
Length	5,068 mm (199.53 in)
Width	720 mm (28.35 in)
Height	742 mm (29.21 in)

1.2 Containment Boundary

The primary containment boundary is the fuel rod cladding. The fuel rod is assembled by loading the uranium dioxide pellets into a zirconium alloy cladding tube. The tubes are pressurized with helium. Zirconium end plugs are welded to the tube which effectively seals and contains the radioactive material.

1.3 Drawings

This package is constructed in accordance with the Global Nuclear Fuel (GNF) Drawing Nos.:

Outer Container Drawings	Inner Container Drawings	Contents Containers
105E3737, Rev. 4	105E3745, Rev. 6	105E3773, Rev. 1
105E3738, Rev. 4	105E3746, Rev. 1	0028B98, Rev. 1
105E3739, Rev. 3	105E3747, Rev. 3	
105E3740, Rev. 3	105E3748, Rev. 2	
105E3741, Rev. 1	105E3749, Rev. 4	
105E3742, Rev. 1		
105E3743, Rev. 2		
105E3744, Rev. 2		

1.4 Contents

1.4.1 The Type A content of the package is fresh low enrichment uranium BWR nuclear fuel assemblies or individual fuel rods. The fuel assembly average enrichment is less than or equal to 5.0% U-235 (the fuel rod maximum enrichment is less than or equal to 5.0% U-235).

The Type B content of the package is low enrichment uranium BWR nuclear fuel assemblies or individual fuel rods that meet the ASTM C996-96 standard of enriched commercial grade uranium or enriched reprocessed uranium. The increase in isotopic U-236 caused the contents to fall within the Type B requirements. The fuel assembly average enrichment is less than or equal to 5.0% U-235 (the fuel rod maximum enrichment is less than or equal to 5.0% U-235).

The nuclear fuel pellets loaded in rods and contained in the package are uranium oxides primarily as ceramic UO_2 and U_3O_8. The fuel assemblies loading criteria are given in Table 6-1 and Table 6-2 of the Safety Analysis Report (SAR).

1.4.2 Maximum quantity of material per package

Table 1-1: Maximum weight of uranium dioxide pellets per fuel assembly

Type 8x8 fuel assembly	**Type 9x9 fuel assembly**	**Type 10x10 fuel assembly**
235 kg	240 kg	275 kg

Table 1-2: Maximum Authorized Type B Quantity of Radioactive Material

Isotope	Maximum content[1]
U-232	2.00×10^{-9} g/gU
U-234	2.00×10^{-3} g/gU
U-235	5.00×10^{-2} g/gU
U-236	2.50×10^{-2} g/gU
U-238	9.23×10^{-1} g/gU
Np-237	1.66×10^{-6} g/gU
Pu-238	6.20×10^{-11} g/gU
Pu-239	3.04×10^{-9} g/gU
Pu-240	3.04×10^{-9} g/gU
Gamma Emitters	5.18×10^{5} MeV - Bq/kgU

1. Based on a maximum payload of 275 kg UO_2 per assembly, 242 kg U (550 kg UO_2, 484 kg U total)

1.4.3 Criticality Safety Index: 0.3

2.0 STRUCTURAL

The RAJ-II transport package is comprised of two nested rectangular boxes that have external dimensions of 29.91 in high by 28.35 in wide by 199.53 in long to transport two Boiling Water Reactor (BWR) fuel assemblies or individual rods contained in a cylinder, protective case, or bundled. The inner and outer containers are constructed of stainless steel. The main structural features of the outer container consist of 1) structural angles and a single wall 0.079 in thick steel plate welded to the angles, 2) four inner container clamps with a vibro-isolating device, 3) wood and honeycomb resin-impregnated kraft paper shock absorbers, 4) an outer container lid, and 5) sling positioning angles and protective plates for forklift handling. The inner container is comprised of 1) a double-wall stainless steel sheet structure that surrounds alumina-silicate thermal insulating material, 2) a removable end lid, and 3) a removable top lid. The interior of the inner container is lined with foam polyethylene that acts a shock absorber.

2.1 Structural Design Criteria

The applicant evaluated the package design primarily by a series of drop tests of full-scale prototype specimens to demonstrate that the inner wells and primary lids remain essentially intact under the NCT and HAC. The applicant's package performance acceptance criteria required that test results must support the assumptions used in the criticality safety evaluations. Miscellaneous structural failure modes such as brittle fracture, fatigue, and buckling were also addressed.

2.2 Weights and Centers of Gravity

The maximum gross weight of the package is 3558 lb. The maximum payload weight is 1508 lb. The application states that the vertical center of gravity is approximately 16.57 in above the base of the package. The application also states that the horizontal center of gravity shifts from the geometric center by 3.62 in when loaded. This offset is neglected in lifting and tie down calculations for the entire package but is accounted for with alternate lifting locations on the inner container. Table 2-1 in the Safety Analysis Report (SAR) lists the weights summary of the package.

2.3 Mechanical Properties of Materials

See Section 2.8 of this Safety Evaluation Report for a description of all issues related to the materials of the package.

2.4 General Standards for All Packages (10 CFR 71.43)

2.4.1 Minimum Package Size

The smallest overall dimension of the package is 28.35 in. This is greater than the minimum dimension of 4 ins specified in 10 CFR 71.43(a). Therefore, the package meets the requirements of 10 CFR 71.43(a) for minimum size.

2.4.2 Tamper-Proof Feature

The applicant indicates that a sealing device is inserted through holes in the body of the package and the lid seal pins. This device provides visual evidence of tampering or opening of the package. This satisfies 10 CFR 71.43(b).

2.4.3 Positive Closure

Positive closure is achieved by way of lid bolts for both the top and end of the outer container. This satisfies 10 CFR 71.43(c).

2.4.4 Chemical and Galvanic Reactions

See Section 2.8 of this Safety Evaluation Report for a description of all issues related to the materials of the package.

2.5 Lifting and Tie-Down Standards for All Packages (10 CFR 71.45)

2.5.1 Lifting Devices

The inner and outer container and payload are individually lifted with slings or a forklift. Sling positioning angles or protection plates are used for each method, respectively. In both cases, the package is supported from below and there are no lifting devices that are a structural part of the package. The applicant stated in Section 2.4.1 of the SAR that the lids of both the inner and outer container have lifting devices that were not analyzed because these devices are not intended to lift the RAJ-II package. The applicant indicated that the top lid lifting lugs are labeled “for lid lifting (only)” and performed calculations to determine the result if the loaded package was inadvertently lifted by the lid lugs. The calculations showed that the lifting bar had a factor of safety less than 1.0 against yielding but the lid structure and components remained intact. The applicant concluded that bending of the lifting bar would not prevent the package from performing its intended function.

The inner container alone is lifted in the empty or fully loaded condition using sling fittings that are a structural part of the package. In Section 2.4.1.1 of the SAR, the applicant analyzes the package to gravity loading demonstrating that the lifting devices are able to resist a minimum of three times the applied load without yielding. NRC staff performed confirmatory calculations and concluded the package meets the requirements of 10 CFR 71.45(a)(1) for lifting devices.

2.5.2 Tie-Down Devices

The package does not incorporate any structural feature that is used as a tie-down device. The applicant states in Section 2.4.2 of the SAR that the package is placed on carriers that allow fore and aft bracing or blocking to resist longitudinal forces. The applicant also states that lateral and vertical forces are resisted by slings that pass over the package. Calculations were provided that demonstrated the ability of the package walls to resist the 5g lateral and 2g vertical loads imparted by the slings. This satisfies the requirements of 10 CFR 71.45(b)(1).

2.6 Normal Conditions of Transport (10 CFR 71.71)

2.6.1 Heat

In Section 3.4 of the SAR, the analysis considered direct sunlight and still air at 100 F (38 C). The maximum steady state temperature was determined to be 171 F (77 C). The staff reviewed the analysis results and agrees that the heat condition will not cause degradation of the package materials. The staff agrees that the effects associated with differential thermal expansion of the various package components are negligible. The applicant showed through calculations that the change in the inner diameter of the cladding and the outer diameter of the fuel pellets would not come into contact therefore no stress will be induced on the fuel due to differential thermal expansion. This satisfies the requirements of 10 CFR 71.71(c)(1).

2.6.2 Cold

The structural components of the package are fabricated with stainless steel, which exhibit no brittle fracture at temperatures above -40 F(-40 C). The applicant showed through calculations that the change in the inner diameter of the cladding and the outer diameter of the fuel pellets would not come into contact; therefore, no stress will be induced on the fuel due to differential thermal contraction. The staff agrees with the applicant's conclusion that the requirements of 10 CFR 71.71(c)(2) are satisfied.

2.6.3 Reduced External Pressure

Under a reduced external pressure of 3.5 psi, the applicant stated that the package cannot develop a differential pressure due to the lack of a pressure tight seal. In addition, the applicant stated that a reduced external pressure of 3.5 psi is negligible when compared with the 161.7 psi internal pressure in the fuel rods and therefore, it was not analyzed. The applicant states in Section 2.6.1.1 that the dust and debris seal is not sufficient to allow pressurization of the package and concluded that no internal pressure exists in the package. The applicant provided calculations to demonstrate that the dust and debris gaskets are not sufficiently compressed to form a pressure seal. This satisfies the requirements of 10 CFR 71.71(c)(3).

2.6.4 Increased External Pressure

The application states that the package does not contain a pressure-tight seal and therefore, no pressure differential exists. The applicant states in Section 2.6.1.1 that the dust and debris seal is not sufficient to allow pressurization of the package and concluded that no internal pressure exists in the RAJ-II package. The applicant provided calculations to demonstrate that the dust and debris gaskets are not sufficiently compressed to form a pressure seal. Because of the pressure equalization, the staff agrees that the package is not subject to extra loading during the increased external pressure tests. This satisfies the requirements of 10 CFR 71.71(c)(4).

2.6.5 Vibration

The RAJ-II package contains an internal vibration isolation mechanism that is fixed to the outer container and supports the inner container. The applicant states that no significant stresses due to vibration will be imparted on the package. This satisfies the requirements of 10 CFR 71.71(c)(5).

2.6.6 Water Spray

The materials of construction of the package are not affected by the water spray test. The staff agrees that the water spray tests of 10 CFR 71.71(c)(6) have negligible effects on the package.

2.6.7 Free Drop

The applicant cited previous testing of the RAJ-II package in which the 4-foot free drop tests was an initial condition for subsequent hypothetical accident condition tests. These tests were performed to identify the worst case accident drop orientations. The applicant also stated that the tests demonstrated the ability of the package to maintain its structural integrity for criticality control. This satisfies the requirements of 10 CFR 71.71(c)(7).

2.6.8 Corner Drop

The corner drop test does not apply since the gross weight of the package exceeds 110 lb, in accordance with 10 CFR71.71(c)(8).

2.6.9 Compression

The application provided an analysis of the package for the compression test by considering a stacking load which is the equivalent of five times the mass of the package. The applicant addressed buckling of the vertical support stiffeners and found the buckling strength satisfactory. Independent NRC staff calculations confirmed that the vertical stiffeners were also satisfactory for yielding in compression. This satisfies the requirements of 10 CFR71.71(c)(9).

2.6.10 Penetration

On the basis of the severity of the 40 inch drop of the package onto a puncture bar, the staff agrees with the applicant's conclusion that the penetration test, using a 13-lb steel rod, will have negligible consequence to the package when compared with the more severe case demonstrated in Section 2.7.3. Therefore, the requirements of 10 CFR 71.71(c)(10) are satisfied.

2.7 Hypothetical Accident Conditions (10 CFR71.73)

The applicant performed two series of drop tests to evaluate structural intergrity on two full-scale certification test units (CTU) with a mock up fuel assembly (an ATRIUM-10 design)with lead rods inside the cladding to replac the fuel pellets. The fuel rods were seal welded using the same techniques used on the production fuel rods.

2.7.1 30-foot Free Drop

Section 2.12.1 of the SAR describes the respective drop tests for the RAJ-II package. CTU 1 was subjected to an oblique (15 degrees from horizontal) 30 ft slap-down on the lid followed by a 40 in oblique (25 degrees from horizontal) puncture test on the lid. A 30 ft end drop was performed on CTU 2. The applicant cited and provided test reports as well as analysis for the RAJ-II package during its development and determined from these tests that the single worst case was a 15 degree slap down impact. The applicant did not perform a side drop or corner drop for this testing sequence. The applicant cited previous testing for the side drop which had some bolt failures in the inner container holding frame but overall was judged to be less severe than the oblique slap down orientation impacting the lid. The corner drop was also determined to be within the failure envelope of the slap down configuration because the corner was able to deform to a greater degree thereby absorbing more of the impact energy.

The 30 ft oblique slap down test showed minor external deformation on both ends of the package. The inner package had no broken bolts on the frame or lids and had significant damage to the inner container and clamp frame. The applicant reported that the fuel assemblies had minimal damage and demonstrated via leak testing that containment had been maintained.

The 30 ft end drop resulted in localized exterior damage at the impact end. The interior showed significant crushing of the wood as well as breaking of the inner wall of the inner container at the location of impact. The applicant also stated that the outer wall was damaged but did not fail completely. The fuel was bent and separated from the spacers, which were damaged, but the rods had no significant damage and containment was verified through leak testing.

The free drop tests, in aggregate, satisfy the requirement of 10 CFR 71.73(c)(1).

2.7.2 Crush

The package weighs more than 1,100 lbs. Therefore, the dynamic crush test of 10 CFR 71.73(c)(2) does not apply.

2.7.3 Puncture

The 40-in drop puncture test was performed on CTU 1 following the 30-ft free drop tests. The applicant tested one orientation of 25 degrees to the horizontal over the center of gravity. The outer wall was deformed but not breached and contacted the inner container. The inner container and fuel assemblies showed no damage. The orientation was determined based on previous experience with previously licensed packages such as TRUPACT-II (NRC docket 71-9218) and HalfPACT (NRC docket 71-9279). The rational for this particular orientation was based on maximizing the likelihood of the 1/4" radius tearing the outer and inner container walls and damaging the fuel locally. The staff agrees that the tests satisfied the intent of 10 CFR 71.73(c)(3).

2.7.4 Thermal

See Section 3.0 of this Safety Evaluation Report for a description of all issues related to the thermal performance of the package.

2.7.5 Immersion - Fissile

The applicant noted that package is not leak tight under external overpressure and that water is assumed to be present in the inner wells for the criticality analysis. Therefore, the package structure is not subject to the loading of the water immersion test. The requirements of 10 CFR 71.73(c)(5) are met.

2.7.6 Immersion - All Packages

The package is not leak tight under external overpressure and water is assumed to be present in the inner wells for the criticality analysis. Therefore, the package structure is not subject to the loading of the water immersion test. The requirements of 10 CFR 71.73(c)(6) are met.

2.8 Materials

The applicant provided a general description of the materials of construction in Sections 1.2 and 2.2 of the application, and Drawing Nos. 105E3737, 105E3738, 105E3741 and 105E3743. The staff reviewed the information contained in these sections and the information presented in the drawings to determine whether the Model RAJ-II meets the requirements of 10 CFR Part 71. In particular, the following aspects were reviewed: materials selection, applicable codes and standards, chemical and galvanic reactions, specification, and long-term package performance.

2.8.1 Structural Materials

The major structural component of the package (e.g., inner and outer container) is fabricated from 304 austenitic stainless steel. The properties of this type of steel include high strength, ductility, resistance to corrosion, and metallurgical stability. Because there is no ductile-to-brittle transition temperature in the range of temperatures expected to be encountered prior to or during transport, the susceptibility of austenitic stainless steels to brittle fracture is negligible. Staff verified the mechanical properties of the steel using ASME Code, Section II, Part D. Because the packages may be fabricated in Japan, the applicant has referenced the equivalent Japanese specifications for the stainless steel material properties, and welding and non-destructive examination specifications. The applicant has stated that the Japanese specifications are equivalent and acceptable to U.S. Codes. The staff concludes that the austenitic stainless steel and the fabrication techniques for the package are acceptable and the requirements of 10 CFR Part 71 are satisfied.

2.8.2 Nonstructural Materials

The staff reviewed Section 2.2 of the application and the SAR drawings essential to safety. Staff reviewed the physical, chemical, thermal, mechanical, and dimensional properties of the shock absorbers and cushioning materials. Based on the information the applicant has submitted, the staff concludes that these material are acceptable for use in the package, and the requirements of 10 CFR Part 71 are satisfied.

2.8.3 Chemical and Galvanic Reactions

In Section 2.2.2 and 2.2.3 of the application, the applicant evaluated whether chemical, galvanic, or other reactions among the materials and environments would occur. In accordance with 10 CFR 71.43(d), the staff reviewed the design drawings and applicable sections of the application to evaluate the effects, if any, of intimate contact between the stainless steel, foam, zirconium fuel cladding, and other components in the package.

The materials used in the construction of the package (e.g., 304 stainless steel, foam, thermal insulator) will not have significant chemical, galvanic, or other reactions in either air or water environment.

The applicant stated that the package may be transported in or near marine environments, which would expose the outer stainless container of the package to the potential effects of chlorides. Chlorides from marine environments may cause localized pitting of the stainless steel. Staff concludes that Section 7.1.1 and Section 8.2.5 of the SAR provides adequate measure to ensure that the package is maintained and consistent with the license drawings in the SAR. The staff has added an inspection requirement to the CoC to ensure the no significant deterioration of the package will compromised its effectiveness.

2.9 Evaluation Findings

On the basis of the review of the statements and representations in the application, the staff concludes that the structural design has been adequately described and evaluated and that the package is capable of maintaining structural integrity to meet the requirements of 10 CFR Part 71.

3.0 THERMAL REVIEW

The staff reviewed the RAJ-II package thermal design and evaluation to assess whether the package temperatures will remain within their allowable values or criteria for NCT and HAC as required in the U.S. Code of Federal Regulations, "Package and Transportation of Radioactive Material" Title 10, Part 71. This application was also reviewed to determine whether the package fulfills the acceptance criteria listed in Section 3 (Thermal Review) of NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material."

3.1 Description of Thermal Design

3.1.1 Design Features

The primary features that affect the thermal performance of the package are 1) materials of construction, 2) inner and outer containers, and 3) thermal insulation of the inner container. Zirconium alloy cladding provides additional protection to the fuel. The applicant has demonstrated that the fuel cladding is stable at high temperatures seen during HAC (see Section 3.3.2 of this Safety Evaluation Report).

3.1.2 Contents Decay Heat

The fuel intended for transport has negligible decay heat. Thermal loads include solar radiation for NCT and a half-hour fire for HAC.

3.1.3 Summary Tables of Temperatures

During NCT, the maximum temperature of 77°C (171°F) occurs on the package exterior. During HAC, a maximum temperature of 648°C (1198°F) occurs at the inner surface of the inner container at the end of the 30-minutes fire. The analysis presented in the SAR adequately demonstrated that the RAJ-II package provides adequate thermal protection for its content.

3.1.4 Summary Tables of Maximum Pressure in the Containment System

For NCT a maximum pressure of 1.33 MPa (192.9 psia) is developed inside the fuel rod, which acts as the primary containment. During HAC, the maximum pressure developed inside the fuel rods is 4.08 MPa (592 psia).

3.2 Material Properties and Component Specifications

3.2.1 Material Properties

Thermal properties of materials that affect the heat transfer both within the package and from the package to the environment are described in Tables 3-1 and 3-2 of the SAR.

3.2.2 Component Specifications

The construction of RAJ-II package package involves materials which are not very sensitive to the temperature range spanning NCT and HAC environment. Some material properties are extrapolated to values not covered by SAR tables but the applicant adequately justified this assumption. The temperature limit for the fuel rods is greater than 800°C (1472°F), according to the pressure evaluation provided in the SAR.

3.3 General Considerations

3.3.1 Evaluation by Analysis

Closed form calculations are used to perform the thermal analysis of the package for NCT. ANSYS finite element models are used to perform the transient thermal analysis of the package for HAC. The analysis model and assumptions are adequately described and justified in the SAR.

3.3.2 Evaluation by Test

Thermal tests were performed on the fuel rods to determine the ability of the cladding (primary containment) to withstand temperatures greater than 800°C (1472°F). During these tests, the fuel rods were heated to various temperatures from 700°C (1292°F) to 900°C (1652°F) for periods longer than an hour to determine the rupture temperature and pressure of the fuel. No failure of the fuel cladding was observed for temperatures as high as 800°C (1472°F).

The thermal properties of the alumina silicate (which provides thermal insulation to the inner container) will be assured in accordance with applicable quality assurance requirements. The package is visually inspected prior to use to assure that the alumina silicate is contained.

3.3.3 Margins of Safety

Maximum allowable service temperatures are specified for each package component. All the package components can operate safely at a temperature of -40°F without any material concern.

3.4 Thermal Evaluation Under Normal Conditions of Transport

3.4.1 Heat and Cold

The decay heat from the fuel assembly is negligible. Since the decay heat load is negligible, the maximum temperature for NCT of 77°C (171°F) occurs on the package exterior. Therefore, according to the analysis results provided by the applicant, ambient temperatures between -40°C(-40°F) and 38°C (100°F) will have no significant affect on the package.

3.4.2 Maximum Normal Operating Pressure

The RAJ-II package is not a pressurized canister and therefore it does not include a pressure tight seal. The fuel rods are pre-filled with helium gas at a pressure of 1.115 MPa (161.7 psia). An assumed maximum normal operating temperature of 77°C (171°F) for the package results in a maximum normal operating pressure (MNOP) of 1.33 MPa (192.9 psia). The above MNOP would not be expected to change over a period of one year due to the insignificant decay heat and stable fuel composition.

3.4.3 Maximum Thermal Stresses

Due to the construction of the RAJ-II package, there are no significant thermal stresses. The package is constructed so that there is no significant constraint on any component as it heats up and cools down.

3.5 Thermal Evaluation Under Hypothetical Accident Conditions

3.5.1 Initial Conditions

The thermal performance of the package under the HAC thermal test was determined using the ANSYS finite element code. The thermal model conservatively assumed that the outer container is not present and the insulating properties of the wood were ignored. The wood used in the inner container is assumed to combust completely providing additional heat source. Initial conditions prior to the fire correspond to normal transport conditions.

3.5.2 Fire Test Conditions

For thermal evaluations under HAC conditions, the RAJ-II package was analyzed to a 30-minute fire at 1475°F. The initial condition prior to the start of the fire is based on the bounding normal transport condition at an ambient temperature of 38°C (100°F) and full insolation before, prior to and following the fire.

3.5.3 Maximum Temperatures and Pressure

The peak fuel rod temperature is assumed to be the same as the inner wall temperature of the package. This temperature reaches its maximum point of 648°C (1198°F) at the end of the fire. This maximum temperature is below the maximum temperature the fuel can withstand without failing. When heated to 800°C (1472°F) the maximum internal pressure of the fuel rods is 4.08 MPa (592 psia). This value is used as the design pressure under HAC.

The maximum temperatures and pressures are within the capabilities that the fuel cladding has been tested to. Therefore the fuel cladding and closure welds of the fuel rods maintain containment during the HAC.

3.5.4 Maximum Thermal Stresses

During thermal testing the fuel rods were heated to 800°C (1472°F) for periods of one hour. No failure of the cladding was observed. Therefore, the fuel rod stresses experienced at 800° (1472°F) are conservatively used as the allowable thermal stresses.

3.6 Appendix

Appendix 3.6 of the SAR included the ANSYS input file for the fire analysis and supplemental calculations performed for the thermal evaluation of the package. This information was found to be consistent with the thermal evaluation presented in the main part of the SAR thermal evaluation.

3.7 Evaluation Findings

Based on review of the statements and representations in the application, the staff concludes that the thermal design of the RAJ-II package has been adequately described and evaluated, and that the thermal performance of the package meets the thermal requirements of 10 CFR Part 71.

4.0 CONTAINMENT REVIEW

The staff reviewed the RAJ-II package to verify that the package containment design has been described and evaluated under NCT and HAC as required in the U.S. Code of Federal Regulations, "Package and Transportation of Radioactive Material" Title 10, Part 71. This application was also reviewed to determine whether the package fulfills the acceptance criteria listed in Section 4 (Containment Review) of NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material."

4.1 Description of the Containment System

The primary containment boundary for the RAJ-II package is the fuel cladding. The containment system includes the ceramic sintered pellet, clad in zirconium tubes that are contained in a stainless steel box that is contained inside an outer stainless steel box. The fuel tubes are tested to demonstrate that they are leak tight (i.e., leak rate$<1X10^{-7}$ atm-cm^3/s).

4.2 General Considerations

4.2.1 Type A Fissile Packages

The fissile material is bound as a ceramic pellet and contained in a zirconium fuel rod which prevents any loss or dispersal of radioactive material.

4.2.2 Type B Packages

The applicant demonstrated a release rate less than $10^{-6}A_2/hr$, therefore satisfying the quantified release rate of 10 CFR 71.51.

4.3 Containment Under Normal Conditions of Transport (Type B Packages)

The welded containment boundary is not affected by any of the NCT as demonstrated by the structural and thermal evaluation. The pressurization that could be seen on the containment boundary is far below the normal conditions the fuel experiences while in service.

4.4 Containment Under Hypothetical Accident Conditions (Type B Packages)

The applicant demonstrated leak tightness of the fuel rods by performing helium leak testing before and after accident conditions. Following the drop test, the fuel rods were leak tested and shown to have a very low leak rate of $5.5X10^{-6}$ cm^3/s. This leak rate would result in a total leak of 3.3 cm^3 for one week. As

described in Section 3, “Thermal Evaluation,” test fuel rods were baked at 800°C

(1472°F) for over 30 minutes and did not leak.

4.5 Leakage Rate Tests for Type B Packages

During manufacturing, each fuel rod is helium leak tested to demonstrate leak tightness (i.e., leak rate<$1X10^{-7}$ atm-cm^3/s).

4.6 Evaluation Findings

Based on the review of the statements and representations in the application, the staff concludes that the RAJ-II containment design has been adequately described and evaluated and that the package design meets the containment requirements of 10 CFR Part 71.

5.0 SHIELDING

Shielding is not needed for the package to meet the external radiation standards in 10 CFR 71.47.

Based on the review of the statements and representation in the application, the staff concludes that the shielding design has been adequately described and evaluated, and that the performance of the package meets the shielding requirements of 10 CFR Part 71.

6.0 CRITICALITY

This section presents the criticality safety results for the RAJ-II transportation package. The purpose of this review is to verify that the package design meets the criticality safety requirements of 10 CFR Part 71 under NCT and HAC.

6.1 Description of Criticality Design

The applicant performed an evaluation to show that the package meets the criticality requirements of 10 CFR Part 71. The applicant performed a criticality analysis for both NCT and HAC. The contents of the package rely on gadolinia loading for criticality control based on enrichment as provided in Table 6-1. There are no spacers required for criticality control. Fissile materials in the payload are limited to an amount that ensures safely sub-critical packages for both NCT and HAC. These limits for the fuel assemblies are shown in Table 6-1 below.

Table 6-1: RAJ-II Fuel Assembly Loading Criteria

Parameter	Units	Type	Type	Type
Fuel Assembly Type	Rods	8x8	9x9	10x10
$U0_2$ Density		#98% Theoretical	#98% Theoretical	#98% Theoretical
Number of water rods	#	0 - 2x2	0, 2 - 2x2 off-center diagonal, 3x3	0, 2 - 2x2 off-center diagonal, 3x3
Number of fuel rods	#	60 -64	72 - 81	91 - 100
Fuel Rod OD	cm	$1.10	$1.02	$1.00
Fuel Pellet OD	cm	#1.05	#0.96	#0.90
Cladding Type		Zirconium Alloy	Zirconium Alloy	Zirconium Alloy
Cladding ID	cm	#1.10	#1.02	#1.00
Cladding Thickness	cm	$0.00	$0.00	$0.00
Active Fuel Length	cm	#381	#381	#385
Fuel Rod Pitch	cm	#1.692	#1.51	#1.350
U-235 Pellet Enrichment	wt%	#5.0	#5.0	#5.0
Maximum Lattice Average Enrichment	wt%	#5.0	#5.0	#5.0
Channel Thickness[a]	cm	0.17 - 0.3048	0.17 - 0.3048	0.17 - 0.3048
Partial Fuel Rods	#	None	8 - 12	8 - 14
Gadolinia Requirements Lattice Average Enrichment[b]				
#5.0 wt% U-235	# @ wt% Gd_2O_3	7 @ 2wt %	10 @ 2wt %	12 @ 2wt %
#4.7 wt% U-235		6 @ 2wt %	8 @ 2wt %	12 @ 2wt %
#4.6 wt% U-235		6 @ 2wt %	8 @ 2wt %	10 @ 2wt %
#4.3 wt% U-235		6 @ 2wt %	8 @ 2wt %	9 @ 2wt %
#4.2 wt% U-235		6 @ 2wt %	6 @ 2wt %	8 @ 2wt %
#4.1 wt% U-235		4 @ 2wt %	6 @ 2wt %	8 @ 2wt %
#3.9 wt% U-235		4 @ 2wt %	6 @ 2wt %	6 @ 2wt %
#3.8 wt% U-235		4 @ 2wt %	4 @ 2wt %	6 @ 2wt %
#3.7 wt% U-235		2 @ 2wt %	4 @ 2wt %	6 @ 2wt %
#3.6 wt% U-235		2 @ 2wt %	4 @ 2wt %	4 @ 2wt %
#3.5 wt% U-235		2 @ 2wt %	2 @ 2wt %	4 @ 2wt %
#3.3 wt% U-235		2 @ 2wt %	2 @ 2wt %	2 @ 2wt %
#3.1 wt% U-235		None	2 @ 2wt %	2 @ 2wt %
#3.0 wt% U-235		None	None	2 @ 2wt %
#2.9 wt% U-235		None	None	None

Parameter	Units	Type	Type	Type
Polyethylene Equivalent Mass (Maximum per assembly)[c]	kg	11	11	10.2

a. Transport with or without channels is acceptable
b. An equivalent gadolinia loading is acceptable
c. Required gadolinia rods must be distributed symmetrically about the major diagonal

Cylindrical fuel rods containing unirradiated $U0_2$, enriched to 5 wt.% U-235, are analyzed within the RAJ-II inner container in 5 in stainless steel pipe, protective case or bundled together. The fuel rod loading criteria, determined from the criticality evaluation for the RAJ-II package, are shown in Table 6-2.

Table 6-2: RAJ-II Fuel Rod Loading Criteria

Parameter	Units	Type	Type	Type
Fuel Assembly Type		8 x 8	9 x 9	10 x 10
UO_2 Density		#98% theoretical	#98% theoretical	#98% theoretical
Allowable number of fuel rods per container compartment:	#			
Configured loose		#25	#25	#25
Configured in 5-inch SS Pipe/Protective Case		#22	#26	#30
Configured strapped together		#25	#25	#25
Fuel Rod OD	cm	$1.10	$1.02	$1.00
Fuel Pellet OD	cm	#1.05	#0.96	#0.90
Cladding Type		Zirc. Alloy	Zirc. Alloy	Zirc. Alloy
Cladding ID	cm	#1.10	#1.02	#1.00
Cladding Thickness	cm	$ 0.00	$ 0.00	$ 0.00
Active Fuel Length	cm	#381	#381	#385
Maximum U-235 Pellet Enrichment	wt%	#5.0	#5.0	#5.0
Maximum Average Fuel Rod Enrichment	wt%	#5.0	#5.0	#5.0

Chapter 6 of the application was reviewed for completeness of information and consistency with other chapters and drawings. The information, parameters, and dimensions provided were sufficient to perform a review and are consistent throughout the application. Chapter 6 presents the results of the applicant's criticality analyses. The criticality results were found to be below the applicable regulatory limit.

6.2 Fissile Material Contents

The uranium to be transported in the RAJ-II container is $U0_2$ pellets, enriched to a maximum of 5 wt% U-235, enclosed in zirconium alloy cladding. The maximum plutonium concentration is very small (Table 1-2). Only 75 percent credit is taken for the gadolinia present in the fuel rods. The fuel rods are arranged in 8x8, 9x9, or 10x10 square lattice arrays at fixed center-to-center spacing. Fuel rods may also be transported loose with no fixed center-to-center spacing, bundled together in a close packed configuration, or inside a 5 in diameter stainless steel pipe or protective case with limits as shown in Table 6-2.

Water exclusion from the inner container is not required for this package design. The inner container is analyzed in both undamaged and damaged package arrays under optimal moderation conditions and is demonstrated to be a favorable geometry.

6.3 General Considerations

6.3.1 Model Configuration

The applicant evaluated a single package and array configurations for both NCT and HAC. The models in Section 6 of the application were reviewed and found to be consistent with the drawings and contents in Section 1 of the application.

Components important to criticality safety are described below.

The RAJ-II is comprised of two primary components: 1) an inner stainless steel container, and 2) an outer stainless steel container. It is lined with polyethylene foam having a density of up to 0.080 g/cm^3. The fuel assemblies rest against the polyethylene foam in a fixed position, and the inner container is positioned within the outer container as shown in Figure 6-5 of the SAR. The inner container has alumina silicate thermal insulation between the inner and outer walls. Water at 1.0 g/cm^3 between the inner and outer containers is used as a conservative replacement in the model for the honeycomb shock absorbers because it is more effective in thermalizing neutrons; and, therefore, more reactive.

The inner stainless steel container is 468.6 cm (184.49 in) in length, 45.9 cm (18.07 in) in width, and 28.6 cm (11.26 in) in height. Containment is provided by the cylindrical zirconium alloy tubes. The fuel rods are located inside one of two compartments within the inner container. The compartments are fabricated from 18-gauge (0.122 cm thick) stainless steel, 456.7 cm (179.8 in) in length, 17.6 cm (6.93in) in width and height.

The outer container is 506.8 cm (199.53 in) in length, 72.0 cm (28.35 in) in width, and 64.2 cm (25.28 in) in height (with the skids attached the height is 74.2 cm (29.21 in)). The inner container is held rigidly within the outer stainless steel container by four evenly spaced stainless steel fixture assemblies. Shock absorbers, fabricated from a phenol impregnated cardboard material, are placed at six locations above and below the inner container, and twelve locations on either side of the inner container. The wall for the outer container is fabricated from 14-gauge (0.2 cm thick) stainless steel.

6.3.2 Material Properties

The material specifications used in the criticality analysis were reviewed by the staff for completeness and correctness. The applicant took credit for only 75percent of the gadolinia present in the fuel rods. The staff agrees that the material property delineations presented in Sections 6.3.1 and 6.3.2 of the SAR are consistent with the condition of the package under the tests of 10 CFR 71.71 and 71.73.

6.3.3 Computer Codes and Cross-Section Libraries

The applicant performed the criticality evaluation using the SCALE-PC (version 4.4a) and the 44GROUPNDFB-V cross section set library. Each case was run using the CSAS25 sequence of codes, i.e., BONAMI, NITAWL, and KENO V.a. For each case, 400 generations with 2,500 neutrons per generation were run to ensure proper behavior about the mean value.

6.3.4 Demonstration of Maximum Reactivity

The applicant performed an evaluation of optimum moderation for the package and its contents. The applicant varied the density of the water and the fuel parameters to determine the optimum reactivity for each type of package. The applicant determined the maximum k_{eff} for each enrichment and fissile loading. A summary of the criticality evaluation is shown below.

Table 6-3: RAJ-11 Criticality Evaluation Summary

Case	Bounding Fuel Type	k_{eff}	σ	k_{eff} + 2σ	USL
Fuel Assembly Single Package Normal	GNF 10x10 with worst case fuel parameters and 4, 2 wt% GD_2O_3 fuel rods	0.6904	0.0009	0.6922	0.94254
Fuel Assembly Single Package HAC	GNF 10x10 with worst case fuel parameters and 4, 2 wt% GD_2O_3 fuel rods	0.6754	0.0009	0.6772	0.94254
Fuel Assembly Package Array Normal	GNF 10x10 with worst case fuel parameters and 4, 2 wt% GD_2O_3 fuel rods	0.8598	0.0007	0.8612	0.94254
Fuel Assembly Package Array HAC	GNF 10x10 with worst case fuel parameters and 4, 2 wt% GD_2O_3 fuel rods	0.9396	0.0009	0.9414	0.94254
Fuel Rod Single Package Normal	25 GNF 8x8 fuel rods per container with worst case fuel parameters	0.6365	0.0008	0.6381	0.94254
Fuel Rod Single Package HAC	25 GNF 8x8 fuel rods per container with worst case fuel parameters	0.6532	0.0008	0.6548	0.94254
Fuel Rod Package Array Normal	25 GNF 8x8 fuel rods per container with worst case fuel parameters	0.6365	0.0008	0.6381	0.94254
Fuel Rod Package Array HAC	25 GNF 8x8 fuel rods per container with worst case fuel parameters	0.8577	0.0008	0.8593	0.94254

6.3.5 Confirmatory Analyses

The NRC staff performed confirmatory criticality calculations for NCT and HAC. The staff performed calculations for the maximum enrichment of 5 weight percent U-235 assemblies. Only 75 percent credit was taken for the gadolinia present in the fuel rods consistent with the submitted analyses.

The staff's calculations were performed with SCALE 4.4, using KENO V.a and the 238GROUPNDF/B-V cross section set. The staff's maximum k_{eff} and optimum moderation level agreed well with the applicant's results.

6.4 Single Package NCT Evaluation

The applicant performed an analysis of a single package with optimum internal moderation for both NCT and HAC. The objectives of the analysis are to demonstrate package criticality safety and to determine fuel loading criteria. To accomplish these objectives, calculations were performed to determine the most reactive fuel configuration inside the RAJ-II assembly compartments. Once the fuel configuration was determined, moderator and reflector conditions were investigated.

Initial calculations were performed to find the worst case fuel assembly orientation inside each RAJ-II fuel compartment. Nominal fuel assembly dimensions were used for these initial calculations. When the worst case fuel configuration, moderator/reflector conditions, and package orientation were found, the single package and package array calculations under both NCT and HAC were performed. The single package HAC model is described in Section 6.3.1.1.2 of the SAR. The fuel orientations depicted in Figure 6-8 through Figure 6-15 of the SAR were used. The results of the calculations are shown in Table 6-14 of the SAR. Based on these results, an assembly orientation was found to be bounding for all designs; and, therefore, was used in the package array calculations. The package assembly calculations were then modified for configurations using the gadolinia-urania fuels rods to determine the limits in Table 6-1 of this Safety Evaluation Report.

Calculations performed with the package array HAC model determined the fuel assembly modeling for the single package NCT model. A fuel parameter sensitivity study was conducted and a worse case fuel assembly was developed for each fuel design. The sensitivity study results determined the fuel parameter ranges for the fuel assembly loading criteria shown in Table 6-1 and Table 6-2.

The worst case fuel rod parameters are shown in Table 6-6 of the SAR. The calculations investigate transporting loose fuel rods, bundled fuel rods, and fuel rods in 5 in stainless steel pipe within each RAJ-II shipping compartment. A fuel rod pitch sensitivity study was conducted for each fuel rod type to determine the number of fuel rods that can be transported in a loose configuration within the RAJ-II fuel assembly compartment. A pitch sensitivity study resulted in the minimum and maximum allowable fuel rod quantity for shipping in a loose configuration. The loose rod analysis is used to bound a fuel rod shipment in which fuel rods are strapped or bundled together. A fuel rod pitch sensitivity analysis was also performed to determine the fuel rod quantity that may be transported inside a 5 in stainless steel pipe.

6.5. Single Package HAC Evaluation

The container deformation modeled for the RAJ-II HAC model includes the damage incurred from the 9-meter drop onto an unyielding surface as well as conservative factors. The RAJ-II inner container length is conservatively reduced by 8.1 cm to bound the damage incurred from this drop test. The alumina silicate insulation is assumed to remain in place, since scoping calculations proved that it was a better reflector than water for the worst case moderator conditions in the HAC model. The polyethylene foam, present in the normal model, is assumed to have burned away when exposed to an external fire. As a result, the fuel assemblies are assumed to freely move within the respective compartment resulting in a worst case orientation. The outer container length was reduced by 4.7 cm and the height was reduced by 2.4 cm to bound the damage incurred in the 9-meter drop test.

The reduction in length for the inner and outer containers, the reduction in height for the outer container, the absence of the polyethylene foam, the presence of the insulation, and the fuel assembly freedom of movement are consistent with the physical condition of the RAJ-II package after being subjected to the tests specified in 10 CFR Part 71.

The fuel assemblies are modeled inside the inner container, in one of seven orientations as shown in the SAR. The worst case orientation was chosen for each fuel assembly design considered for transport and used in subsequent calculations. Fuel damage sustained during the 9-meter drop test is simulated as a change in fuel rod pitch along the full axial length of each fuel assembly.

6.6. Evaluation of NCT Package Arrays

The RAJ-II package NCT described in Section 6.3.1 of this Safety Evaluation Report was used for NCT package array models. The package array normal condition model consists of a 21x3x24 array of containers, surrounded by a 30.48 cm layer of full density water for reflection. The container array is fully flooded with water at a density sufficient for optimum moderation.

The 8x8 worst case fuel rod was used for this model since it was determined to be the most reactive rod in the fuel rod transport, package array (HAC pitch sensitivity studies). A portion of the RAJ-II fuel rod transport, 21x3x24 package array, NCT model is shown in Figure 6-19 of the SAR. The fuel rod cladding was not modeled. Although the cladding material is removed, the fuel rod external boundary is maintained.

6.7. Evaluation of HAC Package Arrays

The RAJ-II package array HAC model consists of a 14x2x16 array of containers (modeled as described for the single package HAC package), surrounded by a 30.48 cm layer of full density water for reflection. The container array has no interspersed water between the packages in the array and no water in the outer container. These moderator conditions optimize the interaction between packages in the array. The inner container is fully flooded with water at a density sufficient for optimum moderation.

A pitch sensitivity was performed which resulted in the minimum and maximum allowable fuel rod quantity for shipping rods in a loose configuration. The loose rod analysis was used to bound a fuel rod shipment in which fuel rods will be strapped or bundled together. A fuel rod pitch sensitivity analysis was also performed to determine the fuel rod quantity that may be transported inside a 5 in stainless steel pipe as shown in Table 6-2. The RAJ-II package array HAC model consists of a 14x2x16 array of containers (modeled as described for the single package HAC package), surrounded by a 30.48 cm layer of full density water for reflection. The container array has no interspersed water between the packages in the array and no water in the outer container. These moderator conditions optimize the interaction between packages in the array. The inner container is fully flooded with water at a density sufficient for optimum moderation.

For the RAJ-II, undamaged packages have been analyzed in 21x3x24 arrays and damaged packages have been analyzed in 14x2x16 arrays. Pursuant to 10 CFR 71.59(a)(2), the more restrictive value of "N" is used to determine the Criticality Safety Index (CSI). The CSI is then derived from this value of "N" per 10 CFR 71.59(b).

The RAJ-II criticality analysis demonstrates safety for 5N = 1,512 (undamaged) and 2N = 448 (damaged) packages. The corresponding CSI of nonexclusive use vehicles is given by CSI = 50/N. Since 5N = 1,512 and 2N = 448, it follows that N = 224, and CSI = 50/224 = 0.223. Rounding up to the nearest tenth, the value becomes CSI = 0.3. Using this rounded CSI result, the maximum allowable number of packages per non-exclusive use vehicle is 50/0.30 = 166.

6.8. Benchmark Evaluations

The applicant performed a benchmarking analysis to show that the code and cross section set (SCALE-PC version 4.4a) accurately determines the k_{eff} of low enriched uranium systems. The applicant performed a criticality evaluation for 27 critical benchmark experiments with compositions, configurations, and nuclear characteristics that are comparable to those encountered in the RAJ-II package loaded with fuel as described in Table 6-1.

The applicant analyzed the data using USLSTATS program from NUREG/CR-6361, “Criticality Benchmark Guide for Light-Water-Reactor Fuel in Transportation and Storage,” method 1. The applicant trended the k_{eff} as a function of the critical experiment system parameters: enrichment, water-to-fuel ratio, hydrogen-to-U-235 ratio, pin pitch, average energy of the lethargy causing fission, and the average energy group causing fission. The applicant then determined the upper subcritical limit (USL) for the selected critical experiments. Figure 6-68 of the SAR displays the USL curve extrapolation using k(x)-w(x); the extrapolated USL value corresponding to the 5.0 wt. percent U-235 enrichment is 0.94323. Because the extrapolated value results in a higher USL than the maximum enrichment within the range of applicability would produce, the USL corresponding to the 4.31 wt. percent U-235 enrichment of the selected experiments is conservatively selected. Therefore, the USL for the RAJ-II package is 0.94254.

6.9 Evaluation Findings

Based on review of the statements and representations in the application, the staff concludes 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.

6.10 References

American Nuclear Society, "American National Standard for Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors," ANSI/ANS 8.1-1983 (R1988), LaGrange Park, Illinois.

U.S. Nuclear Regulatory Commission, "Criticality Benchmark Guide for Light-Water-Reactor Fuel in Transportation and Storage Packages," NUREG/CR-6361, January 1997.

U.S. Nuclear Regulatory Commission, "Recommendations for Preparing the Criticality Safety Evaluation of Transportation Packages," NUREG/CR-5661, April 1997.

U.S. Nuclear Regulatory Commission, "Standard Review Plan for Transportation Packages for Radioactive Material," NUREG/CR-1609, March 31, 1999.

7.0 OPERATING PROCEDURES

Chapter 7 of the application specifies operating procedures for the package. The chapter includes sections on the preparation of the RAJ-II for shipment, package receipt, loading of the RAJ-II, preparation of the package for transport, unloading, and shipping as an empty package. The Certificate of Compliance has been conditioned to specify that the package be operated and prepared for shipment in accordance with Chapter 7 of the application, as supplemented.

Based on the statements and representations in the application, the staff concludes that the operating procedures have been adequately described and evaluated and that the package meets the requirements of 10 CFR Part 71.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

Section 8.1 of the application specifies various acceptance tests which will be performed prior to the first use of the package. These tests include weld examinations and verification that package components are within tolerances on the engineering drawings.

Section 8.2 of the application specifies a maintenance program for the package. The maintenance program includes visual examinations. The Certificate of Compliance has been conditioned to specify that the package be acceptance tested and maintained in accordance with Chapter 8 of the application, as supplemented.

Based on the statements and representations in the application, the staff concludes that the acceptance tests and maintenance program have been adequately described and evaluated and that the package meets the requirements of 10 CFR Part 71.

CONDITIONS

The Certificate of Compliance includes the following conditions of approval:

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

(a) The package shall be prepared for shipment and operated in accordance with the operating procedures in Chapter 7 of the application, as supplemented; and

(b) Each package must be acceptance tested and maintained in accordance with the Acceptance Tests and Maintenance Program in Chapter 8 of the application, as supplemented; and,

(c) Prior to each shipment, the stainless steel components of the package must be visually inspected. Packages in which stainless steel components show pitting corrosion, cracking, or pinholes are not authorized for transport.

CONCLUSION

Based of the statements and representations in the application, as supplemented, and the conditions listed above, the staff concludes that the design has been adequately described and evaluated and the package meets the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9309, Revision No. 0,
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