71-9309

Global Nuclear Fuel

A Joint Venture of GE, Toshiba, & Hitachi

Global Nuclear Fuel – Americas, LLC
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May 25, 2005

Mr. E. William Brach, Director
Spent Fuel Project Office, M/S O-13D13
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Modification to Equivalence Formula

References:
(1) Docket Number 71-9309
(2) Application for Approval of the RAJ-II Package Dated 3/31/04
(3) Request for Revision to the Application for the RAJ-II Package Dated 4/22/04
(4) NRC Request for Addition Information for Model No. RAJ-II Package Dated 7/19/04
(5) Response to RAI Letter and Revisions for the RAJ-II Package Dated 09/03/04
(6) Modification to the 9/3/04 Application for the RAJ-II Package Dated 9/16/04
(7) Modification to the 9/16/04 Application for the RAJ-II Package Dated 10/28/04
(8) Updated Information for the Model RAJ-II Package Application Dated 11/8/04
(9) Modification to Tables of the SAR Dated 11/29/04
(10) Update Drawings for the Model RAJ-II Package Application Dated 4/8/05

Dear Mr. Brach:

Global Nuclear Fuel - Americas, L.L.C. (GNF-A) facility in Wilmington, North Carolina, hereby provides a correction to the polyethylene equivalency equation found on page 6-36 of our SAR for the RAJ-II shipping package. The error was identified as a result of discussions with your staff. This change does not impact any of the calculations used to demonstrate safety of the RAJ-II package.

The following Attachments are provided with this letter:

Attachment 1 is a description of the change to the formula

NMSS01

Attachment 2 contains the changes for page 6-36 of the SAR. Also page 6-35 is provided unchanged from the previous submittal since it is the front of the double-sided page. A vertical line has been placed in the right hand column (on page 6-36) showing where changes have been made. These pages are provided for replacement in the RAJ-II books you currently have.

Six copies are provided for your use.

Please contact me on (910) 675-5656 if you have any questions or would like to discuss the matter further.

Sincerely,

Global Nuclear Fuel-Americas, LLC

Charles M. Vaughan

Charles M. Vaughan, Manager
Facility Licensing

Attachments

cc: CMV-05-030
Framatome
Nick Baker, NRC, NMSS, Washington, D.C.
Dr. W. Travers, NRC, Atlanta, GA

Attachment 1

Description of Changes

Page that Changed	Description of Changes/Reason
RAJ-II SAR Page6-36, Section 6.3.2.2, Material Specifications	The numerator 0.0822 on the equivalency equation in the middle of the page should be changed to 0.137 for the following reason. The polyethylene mass on the equation right side is adjusted by the ratio of the hydrogen number densities for the polyethylene plastic and a given plastic mixture. The numerator should consist of the polyethylene density (volume average density of 0.949 g/cm^3) and the hydrogen wf in polyethylene plastic (0.144). However, an unintended additional factor of 0.6022 is included in the numerator. The 0.6022 value is Avogadro's number adjusted by a conversion factor of 10^{-24} cm^2/barn. Since this value is present in both the numerator and denominator, it cancels out. The correct formula for polyethylene equivalence is: $M_{eq,i} = M_{poly} \times [(rho_{mix,poly})(wf_{H,\ poly})]/[(rho_{mix,i})(wf_{H,i})]$ $= M_{poly} \times [(0.949\ g/cm^3)(0.144)]/[(rho_{mix,i})(wf_{H,i})]$ $= M_{poly} \times (0.137\ g/cm^3)/[(rho_{mix,i})(wf_{H,i})]$ The last four lines above have been added following the equation on page 6-36 for further clarification.

Attachment 2

Page changes for page 6-36 of the SAR

Page 6-36 is identified with Docket Number 71-9309, the applicable revision number and date. A vertical line in the right hand column indicates the location of the revised portion. Because this page is double-sided in the SAR, the front side of this page (page 6-35) will remain unchanged.

Table – 6-8 Material Specifications for the RAJ-II

Material	Density (g/cm^3)	Constituent	Atomic Density (atoms/b-cm)
$U(5.0)O_2$ 98% Theoretical Density	10.74	U-235	1.2128×10^{-3}
		U-238	2.2753×10^{-2}
		O	4.7931×10^{-2}
$U(5.0)O_2$-Gd_2O_3 98% Theoretical Density 2 wt% Gd_2O_3	10.74	U-235	1.18663×10^{-3}
		U-238	2.22611×10^{-2}
		O	4.80517×10^{-2}
		Gd-152	1.54162×10^{-6}
		Gd-154	1.68041×10^{-5}
		Gd-155	1.14083×10^{-4}
		Gd-156	1.57789×10^{-4}
		Gd-157	1.20635×10^{-4}
		Gd-158	1.91474×10^{-4}
		Gd-160	1.68504×10^{-4}
Zirconium	6.49	Zr	4.2846×10^{-2}
Stainless Steel 304	7.94	Fe	5.8545×10^{-2}
		Cr	1.7473×10^{-2}
		Ni	7.7402×10^{-3}
		Mn	1.7407×10^{-3}
		Si	1.7025×10^{-3}
		C	3.1877×10^{-4}
		P	6.9468×10^{-5}
Polyethylene Foam	≤ 0.08	C	3.4374×10^{-3}
		H	6.8748×10^{-3}
Low Density Polyethylene (LDPE) Insert	0.925	C	3.9745×10^{-2}
		H	7.9490×10^{-2}
Polyethylene Cluster Assembly	0.949	C	4.0776×10^{-2}
		H	8.1552×10^{-2}
Alumina Silicate [Al_2O_3(49%)-SiO_2(51%)]	0.25	Al	1.4474×10^{-3}
		Si	1.2783×10^{-3}
		O	4.7277×10^{-3}
Paper Honeycomb $C_6H_{10}O_5$	0.04 – 0.08	C	1.7840×10^{-3}
		H	2.9733×10^{-3}
		O	1.4867×10^{-3}
Full Density Water	1.0	H	6.6769×10^{-2}
		O	3.3385×10^{-2}

Polyethylene inserts or polyethylene cluster separators are positioned between fuel rods at various locations along the axis of the fuel assembly to avoid stressing the axial grids during transportation. The inserts are shown in Figure 6-1 while the separators are shown in. The Low Density Polyethylene (LDPE) insert has a 0.925 g/cm^3 density and an approximate volume of 25 cm^3. Therefore, a 10x10 assembly with 9 polyethylene inserts has a 225 cm^3 total LDPE volume required for one location along the fuel assembly.

The cluster separator is composed of LDPE (0.925 g/cm^3) fingers and a High Density Polyethylene (HDPE, 0.959 g/cm^3) holder (The LDPE and HDPE densities are based on accepted industry definitions). The LDPE fingers (10x10) occupy an approximate volume of 38 cm^3 while the HDPE holder has an approximate volume of 85 cm^3. A volume average density of 0.949 g/cm^3 is calculated for the polyethylene cluster assembly, i.e.

$$\left[\frac{(38cm^3 \times 0.925g/cm^3) + (85cm^3 \times 0.959g/cm^3)}{123cm^3}\right]$$

For a 10x10 assembly, two cluster separators, shown in Figure 6-2, are placed at numerous locations along the fuel assembly. A total polyethylene volume of 246 cm^3 is calculated for each location in which the cluster separators are placed. The RAJ-II criticality calculations use the 10x10 cluster separator characteristics for the fuel types investigated. However, the polyethylene characteristics are only used to establish a polyethylene mass limit so that an accurate measurement of polyethylene characteristics by the user is unnecessary. Other plastics with equivalent hydrogen mass limits are acceptable. The following equation can be used to determine plastic mass equivalence for another plastic material (denoted by subscript "i"):

$$M_{eq,i} = M_{poly} \times \frac{0.137}{(\rho_{mix,i} \times wf_{H,i})}$$

The formula for polyethylene mass equivalence is:

$M_{eq,i} = M_{poly} \times [(rho_{mix,poly})(wf_{H,\ poly})]/[(rho_{mix,i})(wf_{H,i})]$

$= M_{poly} \times [(0.949\ g/cm^3)(0.144)]/[(rho_{mix,i})(wf_{H,i})]$

$= M_{poly} \times (0.137\ g/cm^3)/[(rho_{mix,i})(wf_{H,i})]$

The fuel parameters used to calculate volume fractions for the water and polyethylene mixture are shown in Table 6-9 RAJ-II Normal Condition Model Fuel Parameters. The volume fractions of polyethylene and water for each fuel assembly type analyzed are shown in Table 6-10 RAJ-II Normal Condition Model Polyethylene and Water Volume Fractions. The volume fractions in Table 6-10 are entered into the model input standard composition specification area. Mixtures representing the polyethylene inserts between fuel rods are created using the compositions specified, and used in the KENO V.a calculation. The mixtures are also used in the lattice cell description to provide the lump shape and dimensions for resonance cross-section processing, the lattice corrections for cross-section processing, and the information necessary to create cell-weighted cross-sections.

Table 6-9 RAJ-II Normal Condition Model Fuel Parameters

Fuel Assembly	Fuel Rod OR (cm)	Number of Fuel Rods	Fuel Rod Pitch (cm)	Fuel Rod Length (cm)	Cluster Separator Volume Surrounding Fuel (cm^3)	Fuel Rod Positions
10x10	0.50	92	1.350	385	10,743.5	81