ENCLOSURE 3

M230073

Changed Pages for NEDO-33869 Revision 11

Non-Proprietary Information

IMPORTANT NOTICE

This is a non-proprietary version of M230073 Enclosure 2, which has the proprietary information removed. Portions of the document that have been removed are indicated by white space with an open and closed bracket as shown here [[ ]].

Revision Summary

Revision	Description
0	Initial Issue
7.1	Revised to incorporate administrative updates to align the SAR to the current Certificate of Compliance, provide clarifications, and correct minor errors.
8	Withdrawn
9	Modified to reflect changes to the GNF 10x10 fuel.
10	Revised to incorporate changes in response to Revision 9 requests for additional information 1.0 and 7.0.
11	Revision affecting all chapters to provide safety analysis results for LEU+ (Low-Enriched Uranium (=8 wt% U-235)). Revised to add the general arrangement drawings in Chapter 1 and to provide clarifications in Sections 1.2.2 and 4.5.1.1.

Revision 11 Detailed Revision Summary

Location	Description of Change
Chapter 1	
Chapter 1	Incorporation of new 8.0 wt% U-235 contents throughout chapter.
Section 1.2.2	Revised the first paragraph to delete PWR fuel assemblies.
Table 1-3 Section 1.2.2.1	Incorporation of new 8.0 wt% U-235 contents.
Section 1.1 Section 1.2.2.4.1 Section 1.2.2.4.2	Incorporation of 8.0 wt% U-235 contents CSI values.
Section 1.2.1	Incorporation of aluminum honeycomb material throughout section.
Section 1.2.2.7	Incorporation of 8.0 wt% U-235 maximum decay heat.
Appendix 1.3	Incorporation of latest drawing revisions.
Chapter 2	
Chapter 2	Administrative and grammatical updates throughout chapter.
Section 2.1 Section 2.2 Table 2-3 Section 2.12.2.2	Incorporated aluminum as possible honeycomb construction material.
Section 2.1.2.4.3 Section 2.3.2 Section 2.7.1	Removed paper description of honeycomb.
Section 2.1.4	Included 8.0 wt% U-235 LEU+ fuel content.
Section 2.7.1.3 Section 2.12.2.3 Section 2.12.3.2 Table 2-12 Table 2-13 Figure 2-44 Figure 2-45 Figure 2-46 Figure 2-47	Corrected GNF-J corner drop test orientation description.
Chapter 3	
Chapter 3	Administrative and grammatical updates throughout chapter.
Section 3.1.1	Clarified location of alumina silicate within inner container.
Section 3.1.3	Clarified NCT inner container maximum temperatures. Clarified temperatures are based on analysis with paper honeycomb material.
Figure 3-1	Removed paper description of honeycomb.
Section 3.2.1	Incorporated aluminum as possible honeycomb construction material.
Section 3.3	Clarified the maximum NCT temperature of the inner container is the starting point for the HAC.
Table 3-5	Updated table titles to clarify data is based on analysis with paper honeycomb

Location	Description of Change
Table 3-6 Table 3-8	material.
Section 3.5.3	Added statement about aluminum honeycomb material for the analysis. Clarified the maximum temperature within the inner container during NCT.
Table 3-8	Corrected column header to clarify T thru IC Outer Shell.

Chapter 4	
Chapter 4	Administrative and grammatical updates throughout chapter. Incorporation of new 8.00 wt% U-235 enriched contents throughout chapter.
Table 4-2 Table 4-3 Table 4-5	Updated tables to incorporate 8.00 wt% U-235 contents. Added new Table 4-5
Section 4.5.1.1	Added text to state that the other uranium isotope concentrations are impacted by the change from 5.0 wt% U-235 to 8.0 wt% U-235, but that the concentrations are bounded by the reprocessed feed assumption and corresponding uranium isotope concentrations. Also added text to state that the activities of the uranium isotopes at 8.0 wt% U-235 are considered to be bounded by the reprocessed feed assumption and corresponding uranium isotope concentrations.
Section 4.5.1.1 Section 4.5.1.2 Section 4.5.1.3 Section 4.5.1.4	Incorporated calculation of 8.00 wt% U-235 contents.
Chapter 5	
Chapter 5	Administrative updates throughout chapter. Incorporation of new 8.00 wt% U-235 enriched contents throughout chapter.
Table 5-1	Updated per LEU+ analysis Added "* Transport index may not exceed 10."
Section 5.2.1	2nd paragraph changed "3.73E+10" to "3.89E+10" per LEU+ analysis Updated Reference
Table 5-2	Updated per LEU+ analysis
Section 5.2.2	1st paragraph - Changed "9.94E+03," "5.74E+03," and "4.20E+03" to "9.77E+03," "5.56E+03," and "4.21E+03," respectively per LEU+ analysis 2nd paragraph - Changed "0.7095" to "less than 0.95" 3rd paragraph - Changed "1.99E+05" to "1.95E+05"
Section 5.4.4	Changed "93%" to "92%" and added "with the limiting result being one meter from the top of the package surface under NCT" in the last sentence.
Reference 5-1	Changed "C996-15" to "C996-20" (latest revision)
Chapter 6	
Section 6.1	Addition of definitions of LEU and LEU+.Addition of general description of Ch. 6 Revision 11 change methodology.
Table 6-1	Addition of LEU+ CSI designations and new LEU+ gadolinia rod requirements.

The only significant protrusions on the inner container exterior are the lifting sling fittings and the tightening blocks that are used for securing the lid. There are lifting sling fittings on the body and the main lid. Each of the sling fittings fold down so they protrude only the thickness of the lifting rod or bail.

1.2.1.5.2 Lifting and Tie-Down Devices

The lifting devices for the RAJ-II consist of the sling holding angles on the outer container which keep the slings from moving when used to sling the container during handling. The loaded outer container is designed to use two slings under the container. The empty container is also handled with two slings. The package may also be handled by the use of a forklift. The sling holding angles are designed so that even if they failed it would not affect the performance of the package.

The inner container is handled by the use of a series of lifting sling fittings. They are attached in a manner that even if they fail it will not compromise the performance of the inner container. On both the inner and outer containers, the lid lifting devices are marked to ensure proper use. A detailed discussion of lifting and tie-down designs, with corresponding structural analyses, is provided in Sections 2.4.1 and 2.4.2.

1.2.1.6 Heat Transfer Features

Unirradiated fuel has insignificant decay heat; therefore, the RAJ-II package is not designed for dissipating heat. A more detailed discussion of the package thermal characteristics is provided in Chapter 3.0. Due to the passive design of the RAJ-II package with regard to heat transfer, there are no coolants utilized within the RAJ-II package.

1.2.1.7 Packaging Markings

The packaging will be marked with its model number, serial number, gross weight and also with the package identification number assigned by the Nuclear Regulatory Commission (NRC).

1.2.2 Contents

This package is intended to be used to transport unirradiated BWR fuel assemblies, BWR fuel rods, CANDU fuel rods, and PWR fuel rods, containing Type B fissile material. The fissile material can be in the form of uranium dioxide or uranium carbide enriched up to 5.0 wt% U-235, referred to as LEU for the purposes of this report, or uranium dioxide up to 8.0 weight percent (wt%) U-235, referred to as LEU+ for the purposes of this report. Loading criteria and details for fuel assemblies are specified later in Table 6-1 and fuel rods in Table 6-2.

1.2.2.1 Maximum Quantity of Fissile and Radioactive Materials

The contents consist of enriched commercial grade uranium or enriched reprocessed uranium, as defined in ASTM C996-20, uranium oxide or uranium carbide fuel rods enriched to 5.0 wt% U-235 for LEU or uranium oxide fuel rods enriched to no more than 8.0 wt% U-235 for LEU+, with limits specified in Table 1-2 and Table 1-3. For the limits of Table 1-3, U-238 is considered the remainder. See Chapter 4 for the A_2 –effective calculation.

4.5 APPENDIX

4.5.1 Determination of Allowable Leak Rates

This section calculates the package A_2 effective, activity concentration limits, allowable NCT release and leak rates, and allowable HAC release and leak rates for the 10x10 fuel assembly content.

4.5.1.1 Calculation of Package A_2 Effective

In order to determine the package allowable leak rate, the A_2 effective of the content mixture is first determined. The A_2 effective is based on the maximum amount of radioactive material shipped in a 10x10 fuel assembly, comprised of reprocessed uranium in solid form as ceramic uranium dioxide that is enriched to no more than 5.0 wt% U-235 for LEU fuel and 8.0 wt% U-235 for LEU+ fuel for the purposes of this report. The package is assumed to have two assemblies, each with 100 rods. The uranium and other nuclides in the fuel are considered to be dispersible solids that have homogenous distribution.

The total activity is calculated for a package payload of two assemblies containing 550 kg UO_2 (484 kg U) with a nuclide specification for enriched reprocessed fuel. Table 4-1 summarizes the maximum radionuclide concentration from American Society for Testing and Materials (ASTM) Specification C996-20 (Reference 4-2) with specific alpha emitting isotopes defined based on allowable fuel composition. While not considered a maximum concentration listed in Table 4-1, the U-238 concentration is assumed as the remainder of the uranium concentration.

Table 4-1 RAJ-II Content Radionuclide Maximum Concentrations for 5.0 wt% U-235

Radionuclide	Maximum Content
U-232	0.050 μg/g U
U-234	2,000 μg/g U
U-235	50,000 μg/g U
U-236	25,000 μg/g U
Tc-99	5 μg/g U
Np-237	1.66 μg/g U
Pu-238	0.0000620 μg/g U
Pu-239	0.00304 μg/g U
Pu-240	0.00304 μg/g U
Gamma Emitters	4.4×10^5 MeV Bq/kg U

Table 4-2 summarizes the maximum radionuclide concentration for 8.0 wt% U-235 LEU+ fuel. Only the U-235 and remainder U-238 concentrations are considered to be impacted. The other uranium isotope concentrations are likely to change going from 5.0 wt% U-235 to 8.0 wt% U-235; however, the concentrations are bounded by the reprocessed feed assumption and corresponding uranium isotope concentrations. Although not considered a maximum concentration, the U-238 concentration is assumed as the remainder of the uranium concentration.

Table 4-2 RAJ-II Content Radionuclide Maximum Concentrations for 8.0 wt% U-235

Radionuclide	Maximum Content
U-232	0.050 μg/g U
U-234	2,000 μg/g U
U-235	80,000 μg/g U
U-236	25,000 μg/g U
Tc-99	5 μg/g U
Np-237	1.66 μg/g U
Pu-238	0.0000620 μg/g U
Pu-239	0.00304 μg/g U
Pu-240	0.00304 μg/g U
Gamma Emitters	4.4×10^5 MeV Bq/kg U

The A_2 and specific activity of each radionuclide, taken from 10 CFR 71 Appendix A, Table A-1, are shown in Table 4-3. Gamma emitter A_2 values are taken from 10 CFR 71 Appendix A, Table A-3, while the specific activity values are calculated based on note instructions applied to Table 4-3. Based on the concentration of each radionuclide, the mass is calculated. The mass is then used to determine the total activity of each radionuclide. The other uranium isotope concentrations are likely to change going from 5.0 wt% U-235 to 8.0 wt% U-235; however, the concentrations are bounded by the reprocessed feed assumption and corresponding uranium isotope concentrations.