

Chapter 6 – Criticality Evaluation

Question

What document, consistent with the fuel composition, specifically address the impact of the transuranic constituents in the fuel on the criticality evaluation?

Response

See document “Fuel Composition” for general information regarding the fuel composition.

Table 1-3 “Type B Quantity of Radioactive Material” of the SAR provides a list of isotopes that could be present in the fuel material. Of these, the criticality analysis explicitly modeled U-235 and U-238. The only other isotope listed in Table 1-3 which may have an effect on the criticality analysis by increasing reactivity is Plutonium-239. Table 1-3 is reproduced below.

Table 1-3 Type B Quantity of Radioactive Material

Isotope	Maximum content ¹	Maximum mass, g	Specific Activity ² , TBq/g	Total Activity, TBq	Total Activity, Ci
U-232	2.00E-09 g/gU	9.92E-04	0.83	8.23E-04	2.23E-02
U-234	2.00E-03 g/gU	9.92E+02	2.30E-04	2.28E-01	6.17E+00
U-235	5.00E-02 g/gU	2.48E+04	8.00E-08	1.98E-03	5.36E-02
U-236	2.50E-02 g/gU	1.24E+04	2.40E-06	2.98E-02	8.04E-01
U-238	9.23E-01 g/gU	4.58E+05	1.20E-08	5.49E-03	1.48E-01
NP-237	1.66E-06 g/gU	8.23E-01	2.60E-05	2.14E-05	5.79E-04
PU-238	6.20E-11 g/gU	3.08E-05	6.30E-01	1.94E-05	5.24E-04
PU-239	3.04E-09 g/gU	1.51E-03	2.30E-03	3.47E-06	9.37E-05
PU-240	3.04E-09 g/gU	1.51E-03	8.40E-03	1.27E-05	3.42E-04
Gamma Emitters ³	5.18E+05 MeV-Bq/kgU	N/A	N/A	2.57E-02	6.94E-01
Total				2.92E-01	7.89E+00

The trace quantity of plutonium present in the fuel matrix has a negligible effect on criticality. This is demonstrated for 8x8, 9x9, and 10x10 fuels in Section 6.6.2.1, Pu-239 Effect on Reactivity for the TN-B1 Package Array Hypothetical Accident Condition. This methodology is repeated in Section 6.12.6.1 for 11x11 fuel, where it is also concluded that “The results indicate no statistically significant difference between the cases with and without plutonium”. Therefore, plutonium is justifiably neglected in the TN-B1 evaluation.