

RAI 6-2

Justify why the material density for UO₂ + Gd₂O₃ is used for pure UO₂ rods in the criticality safety analyses.

On page 407 of the application, the applicant calculated the material density for the fuel rods that are loaded with gadolinium burnable poison. The applicant used a density of 10.96 g/cm³ for UO₂ and 7.407 g/cm³ for Gd₂O₃ to determine the material density of the fuel rods containing gadolinium trioxide. The result shows that a density of 10.763 g/cm³ is appropriate. However, it appears that the applicant used 10.763 g/cm³ as the material density in the criticality safety analyses for non-poisoned fuel rods as well. The material specifications listed in Table 6-60 and the sample input file in Section 6.12.10.1 confirm this observation. The applicant needs to justify why it is appropriate to use the material density of UO₂ + Gd₂O₃ for pure UO₂ rods in the criticality safety analyses or revise the criticality safety analyses as necessary.

This information is needed to determine compliance with 10 CFR 71.55(a), 71.55(b), 71.55(d), 71.55(d), 71.59(a), 71.59(b), and 71.59(c)

AREVA Response

On page 407 of the document, the theoretical density of UO₂ is given as 10.96 g/cm³. This value is then multiplied by the % theoretical density of 98.2 to get the density for UO₂ of 10.763 g/cm³ (ρ_{UO_2}).

On page 407, the density of Gd₂O₃ is given as 7.407 g/cm³ (ρ_{Gd})

The 10.763 g/cm³ value is shown correctly in Table 6-60 as the density for the UO₂ material.

This value is also input correctly for both the pure UO₂ rods (material 1 of the sample input of Section 6.12.10.1) and for the UO₂ material within the UO₂ + Gd₂O₃ material (material 4 of the of the sample input of Section 6.12.10.1). The density of 7.407 g/cm³ is input for the Gd₂O₃ material within the UO₂ + Gd₂O₃ material (material 4 of the of the sample input of Section 6.12.10.1). The density of the combined UO₂ + Gd₂O₃ material is calculated by the code during execution using the input densities and the volume fractions for the materials (also given on page 407 of the document). The density calculated by the code for UO₂ + Gd₂O₃ is 10.691 g/cm³. This value is shown in Table 6-60.

The SAR section 6.12.3.2 "Material Properties", Table 6-60 "Material Specifications for the TN-B1 11x11 Analysis" footnotes, section 6.12.10.1. "11x11 Fuel Assembly, HAC Array, Case '5wt_13gd'" and section 6.12.10.2. "11x11 Fuel Rod Analysis, HAC Array, Case 'mod_in_pipe10_dens010'" have been revised to add cross references to the density calculations and values to the materials in the sample inputs.