Docket 71-9309

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Subject: Comparison of SP.doc

Kim,

Attached reactivity comparison document for packages similar to the RAJ-II. SP is the Siemens Powder variation of the GNF RA. I would suspect that the RA would have similar response characteristics as a result. The NT-IV is used exclusively for shipments to Japan. Please share this with others of interest.

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Comparison of SP, NT-IV, and RAJ-II Packages
Relative to Materials of Construction and the use of Polyethylene Shims and Foam

The SP package uses polyethylene foam intermittently within the inner and outer containers. Foam is used within the inner container only at spacer locations and in the outer container in the bottom and top at four locations. The SP inner container is fabricated of carbon steel of thickness greater than that used in the RAJ-II package. The inner wall of the inner container is fabricated from perforated plate steel which allows the inner cavity of the inner container and the fuel cavity to fill and drain at the same rate. The limited amount of foam does not influence the criticality calculations. In the HAC, the outer wood container is omitted. The single package is most reactive when the inner container is flooded producing a fully moderated fuel lattice and with full water reflection. The package array is most reactive when the inner containers are closely-packed and the fuel-envelop is flooded while the remaining fuel cavity and inner cavity of the inner container are essentially void.

The NT-IV package uses perforated polyethylene foam within the inner container. Perforated foam is used within the full length of the inner container. The perforations in the foam match the perforations in the inner wall of the inner container to allow the inner cavity and the fuel cavity to fill and drain at the same rate. The NT-IV inner and outer containers are fabricated of carbon steel of thickness greater than that used in the RAJ-II package. The single package is most reactive when the inner and outer containers are flooded producing a fully moderated fuel lattice and with full water reflection. The foam reduces the reactivity of the single package. Array calculations considering full length foam (non-perforated) within the inner container indicated slightly higher multiplication values, but statistically indeterminate (Δk_{eff} of 0.0005), when considering flooded fuel bundles. The modeled foam was essentially twice that normally present within the package. With foam of the allowed nominal density, the package array was more reactive with optimum water moderation. The package array is most reactive when the fuel-envelop is flooded while the remaining fuel cavity and inner cavity of the inner container and outer container are essentially void.

The RAJ-II package uses polyethylene foam similar to the NT-IV within the inner container. However, the foam is not perforated and the density is twice that used in the NT-IV package. The allowed mass for cluster separators is more than twice the allowed limit of the NT-IV. Aluminum Silicate is further used between the inner and outer walls of the inner container for thermal protection. The combination of polyethylene foam and Aluminum Silicate makes the package array more reactive due to a combination of less dense material and less neutron thermalization between packages. Less neutron thermalization between packages leads to increased package interaction and decreased absorption in the container steel. However, the increase in the package array reactivity can be partially off-set by discrete modeling of the cluster separators as opposed to cluster smearing along the length of the assembly as assumed with melting. While the ethafoam remains intact it is unlikely that the cluster separator would also melt.

Further, the GNF 10x10 assemblies are more reactive than the FANP 9x9 and 10x10 assemblies evaluated in the NT-IV package. Reduced package-to-package spacing and reduced materials of construction as compared to the NT-IV are factors that lead to a more reactive configuration for the RAJ-II. However, the presence of Aluminum Silicate and foam appears to have caused the majority of the increased interaction between packages leading a higher multiplication factor for this package array.